The Journal

OF THE

Royal United Service Institution.

VOL. VI. 1862. No. XXI.

Evening Meeting.

January 20th, 1862.

Major-General the Hon. JAMES LINDSAY, M.P., Chairman of the Council, in the Chair.

Names of Members who joined the Institution between the 1st and 20th of January, 1862.

Burn, J. M., Lieut. Royal Art. 1*l.*
Furlong, J. M. (M.D.), Surg. 42d High. 1*l.*
Armistead, Rev. C. J., M.A., Chaplain R.N. 1*l.*
Silk, G. C., Lieut. South Mid. Rif. Vol. 1*l.*
Dawson, R. N., Capt. Royal Engs. 1*l.*
Prichard, A., Capt. 28th H.M. Madras N.I. 1*l.*
Julian, T. A., Capt. 52nd Regt. 1*l.*
Rennie, J. (C. B.) Capt. H. M. Indian Navy, 1*l.*
Tupper, De Vic, Capt. 2d Bat. 8th King's, 1*l.*
Vyvyan, W.C., Ens. late 4th King's Own, 1*l.*
Stirling, W., Major Royal Art. 1*l.*

CHAIRMAN'S ADDRESS.

This being the first Evening Meeting of the year, I will, with your permission, before my gallant friend Captain Scott reads his paper, say a few words upon the position of the affairs of this Institution.

In the first place, I have much pleasure in announcing that between the period of our last meeting in this Theatre and the end of the year, 114 Members joined the Institution, making a total of 305 for the year 1861, whilst 11 have joined since the beginning of this year. This may perhaps appear a large number, but when it is considered that the whole of the officers in the navy, army, and other military services are eligible to become Members, it is not greater than what may reasonably be expected in the course of a single year. This Institution, perhaps more than any other, depends upon numbers for its support. From the circumstances and duties of the officers of the army and navy, the subscription must necessarily be small, and therefore the 305 new Members do not represent the same money value as they would in other institutions. The great object which the Council have in view is to make this Institution both interesting and useful to the Members who do not frequent the Metropolis, or who are serving abroad, as well as to those who are able to make personal use of its resources; and I think I am right in the obser-

vation, that perhaps no other Institution gives so much, at so small a cost, to its Members. The more our financial power is increased, the more worthy of the country, and the more valuable as a means of diffusing professional information, the Institution will become.

The Journal is doing good service for the Institution. We are much beholden to the gentlemen who have come forward in this Lecture Theatre to treat upon those professional subjects with which they are conversant, and who promulgate their opinions by means of the Journal to their brother-officers, stationed, as they are, in every part of the world.

The lectures which have been delivered in this Theatre, during the past year, have been for the most part upon that particular subject which my gallant friend on the left continues to-night. We have had no less than eleven papers read during the past season upon iron ships and the improved ordnance. Discussions followed upon most of those papers, conducted with very great ability by naval officers and by civil engineers. In this way it is evident science is improved, information is circulated, and the services, both army and navy, as well as the country at large, are greatly benefited.

The Journal is peculiarly appreciated by the officers serving in the Colonies, who are thus kept *au courant* with the progress of science and with the opinions of those whose time and abilities have been devoted to the study of inventions and improvements in the appliances of modern war. So much is this the case, that of the 305 new Members, no less than 102 who were stationed in India, the Cape, and other dependencies of the Crown, became Members in order that they might receive it. This is an undoubted recognition by the officers of both services of the professional value of the Journal, and we trust by degrees, as it is more and more appreciated, to find the officers on full pay recognising it in a substantial form by enrolling themselves as Members. In the mean time, the expense of printing, illustration, and publication, is very large, while its circulation to all parts of the world is conducted entirely free of expense to those Members who receive it.

The expenses of the staff, of the rent and taxation, of the ordinary business, of the publication and circulation of the Journal, and of the library, as yet absorb the greater part of the receipts. And, although the model departments have not been neglected, the Council hope, as the finances increase, to render them as complete, both in general interest and in utility, as may be worthy of a great professional metropolitan establishment.

Although this Institution has been in existence for upwards of thirty years, it is only recently that it has been able to carry into effect the original designs of its founders. In its earlier years, although its financial capacity was great and sufficient for the intended purposes, yet it laboured for a long time under the disadvantage of inadequate accommodation. By the time the Institution became possessed of all that was required to render itself prominent by its usefulness, its resources were exhausted; the original enthusiasm in its career had abated, the feeling in favour of professional knowledge was at that period at a low ebb, and the income had fallen to an extent which for some time prevented adequate use being made of the improved accommodation.

During the last few years, however, these difficulties have been over-

come. The finances of the Institution are in a vigorous condition, and are concentrated upon the advancement of professional information relating to the naval and military services. A general recognition of the necessity and value of professional studies and discussions has arisen among officers; and the Council has made full use of this opportunity by devoting the resources of the Institution to the advancement of this object. The efforts of the Council have been successful; the officers themselves have been the first to acknowledge their appreciation of all that has been done, and are gradually proving this by tendering their support. The Government have recorded their opinion by proposing a small annual grant to assist the Literary and Scientific Departments; and both the Admiralty and War Departments, when opportunities present themselves, show the favourable opinion they entertain.

When the Commissioners of the International Exhibition of 1862 decided to form a military class, they requested Lord Herbert to nominate a Committee. Lord Herbert at once referred the subject to the Council of this Institution, and requested them to undertake the duties—a distinct recognition of the high character which it held in the opinion of the Secretary of State. Both the Naval and Military Committees have held their sittings in the Council Room of the Institution.

I cannot avoid trespassing upon your time for a few moments upon a subject which has been brought home to the minds of every subject of Her Majesty, throughout the whole length and breadth of the land. I allude to the loss which the country, the army, and this Institution have sustained by the untimely death of the late Prince Consort. Her Majesty became a patron of the Institution shortly after she came to the Throne, and His Royal Highness became joint patron with the Queen in 1841. As soon as he became acquainted with the objects which the Institution was designed to promote, he became a warm supporter.

From the position which I have had the honour to hold for some years, as a commanding officer of a battalion and regiment of Guards of which the late Prince Consort was colonel, I had the privilege of frequently approaching his person, and I occasionally took the opportunity of speaking to him upon the merits of this Institution, when I had the honour to wait upon him. His Royal Highness always expressed himself warmly in its favour, and entered minutely into the position of its affairs, and, when its fortunes were in a low state, into the prospects of improvement. He fully comprehended the cause of prostration, and foresaw the means by which alone it could be restored. His advice was on all occasions most valuable. When we were endeavouring to get a grant from the Government in aid of the finances of the Institution, having failed in two or three instances to impress the Government with a sense of the importance of the objects we had in view, it may be inferred that the warm interest he took, may have indirectly influenced others to acknowledge that the Institution had as much claim to permanent support as other literary and scientific establishments.

Again, he was a great advocate for concentrating our efforts upon those objects which this Institution alone is endeavouring to promote. Formerly we had an Ethnological collection, and a Natural Historical collection. It was his opinion that these collections could never by any possibility be made useful to the officers of the two services. They were imperfect collections at the best, though there some good and valuable

things in them; and the other institutions devoted specially to those particular branches of science, of course, had much better collections.

Again, no later than a few months ago, the lease of these premises approaching its termination, I mentioned to His Royal Highness how necessary it was that we should remain in our present locality. Officers of the Army and Navy, having their clubs in Pall Mall, and occupied at the Admiralty and the Horse Guards, would naturally prefer coming to the Institution in Whitehall, than to have to go to Kensington, or some other remote locality, which, for reasons needless to detail at the present moment, would be ruin to our prospects. It is, therefore, an important object that we should remain here. His Royal Highness saw, as we did, the immense advantage to the Army and Navy of our present position, and the necessity of our continuing in it, and expressed a hope that circumstances would leave us undisturbed.

I cannot but express the feeling that in him we have lost a very sincere friend, and that his good offices would have been of very great assistance to us in maintaining our present position in Whitehall Yard. It was the duty of the Council, at their last meeting in the beginning of January, to prepare an address of condolence to her Majesty upon the irreparable loss which both she and the nation have sustained, and which, signed by the President of the Institution, has since been presented; I am sure the Members, when this is duly reported to them at the next annual meeting, will approve of the step which the Council has taken in performing a duty in common with the rest of the country.

I regret to add that some of our most distinguished Members have died since we last met—General Sir Howard Douglas, upon whose intellect and great abilities age seemed to have little effect, and who contributed within a short time previous to his death opinions upon the great subject of the day, War Ships and Rifled Ordnance, was one of the founders of the Institution, and was the Chairman when it was established. He was an officer of great scientific acquirements, and through a long life, whether in or out of employment, his mind was always actively employed in the service of his country.

Lord Herbert, as a War Secretary, was a warm supporter of this Institution. He saw the value of the policy pursued, and he always cordially entered into our objects and requirements. We have lost in him a friend, who, as far as opportunities permitted, was anxious to advance our interests.

Several distinguished officers have also been removed by death. Among them I cannot forbear mentioning the names of General Sir Charles Pasley, K.C.B., and Vice-Admiral Sir Richard Dundas, K.C.B.; the former was eminent as a military author and engineer, and rendered great services to the nation by his attention to the system of pontooning; the latter commanded the Baltic fleet in the Russian war and was one of the Lords of the Admiralty at the time of his death.

Having said these few words, I will now ask Captain Scott to read the paper which he has prepared. Captain Scott is an old friend of this Institution. He gave us a most valuable paper last year, which has been published in a recent number of the Journal. I am perfectly convinced that, with the abilities he has shown, and the attention he has paid to the subject, there is no paper he can read which will not be most warmly approved of.

THE PROGRESS OF ORDNANCE ABROAD COMPARED WITH THAT OF ORDNANCE AT HOME.

By Commander R. A. E. SCOTT, R. N.

I do not think I can commence this paper better than by quoting the words of the present distinguished Chief of the Admiralty, the Duke of Somerset,* respecting the value of this Institution, in which subjects that are not only professional, but such as are of deep interest to all Englishmen, can be discussed in the fair and open manner necessary to elicit truth. His Grace says:—

"I know in regard to the Navy a great many things are discovered, and are put aside for the want of a proper place to preserve them. Many years afterwards what are thought to be discoveries are made, and we often find, if we had looked back and consulted our papers, that the discoveries had been made a long time ago. That is continually occurring, and it shows of what great advantage an institution of this kind may be, in recording information of this character and communicating it throughout the Services.

"If you adopt as a matter of faith that So-and-so is quite right, and that whoever says to the contrary has a bad motive, and is a dishonest fellow, why, you may settle the question easily in your own mind, but you do not settle it to the interests of the country. What we have to do is to look at these questions calmly in all their bearings, and I am sure, if that were done, we should then arrive at a satisfactory result."

Yet there may still be doubts in the minds of some as to the advisability of speaking the whole truth. Let such persons learn from the wise example of the Emperor across the water in at once exposing the real state of the finances of France, and thus making friends of his people by admitting them to his confidence.

It is only in great minds, and amongst a great people, that there is a readiness to acknowledge error; little minds and a little people try rather to shuffle out of false positions than to frankly admit a mistake; and there may be some who, like the bird that tucks its head under its wing, refuse to see. Such persons would desire to shut out the truth; but of what advantage is it to hide our true position from our own people? "To be forewarned is to be forearmed," the proverb says, and any one who reads the French and other foreign works must know that continental nations narrowly watch our progress, and can estimate the full value of our changes far better than we do ourselves. We indeed have been too well satisfied, to properly consider and carefully weigh the effects of our alterations;

* Vide the Duke of Somerset's speech at the General Annual Meeting, on the 2nd March, 1861.

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but, should war unfortunately take place, the present blind confidence in our armaments might be rudely dissipated, and untried weapons fail us at our utmost need.

Lately public attention has been much occupied with our naval armaments, and there is no subject of greater national importance; for on our maritime supremacy, our high position, nay, our very existence as a great people (humanly speaking), depends. There is therefore a necessity for thoroughly ventilating and settling the matter definitively. This will at once be evident, as well to the landsman present as to the seaman, when he is informed that, in a frigate of 51 guns, he may find, in consequence of our recent changes in ordnance, six different guns, and five different kinds of shot.

The naval artillerist is already too well aware of the disadvantages he will be placed under by such complications, and knows what must result from them when men's nerves are highly strung, comrades falling around, and smoke and splinters filling the decks; and, since there are in this Institution a large proportion of experienced officers both naval and military, I can confidently look for a patient hearing, and an unprejudiced decision upon the truth or error of my views.

In my former lectures, published in the nineteenth number of the Journal, I pointed out defects in the systems which at that moment were enjoying popularity in England, and I have since seen my statements fully confirmed. This evening I will endeavour to place before you what foreign nations are doing, and ask you to join me in contrasting their progress with our own, so as to see how far we have advanced relatively, if not absolutely.

Foreign Rifled Guns of Early Date.

It may cause surprise to hear how early rifled guns were used. In the Arsenal of St. Petersburg is a gun $2\frac{3}{4}$ inches in diameter, and 62 inches in length of bore, which was rifled in nine grooves in 1615. This gun is a breech-loader, and there are several wall-pieces and rifled muskets in the French and other museums, which were grooved about this date on plans that have been lately revived.

In 1661 the Prussians experimented at Berlin with a gun rifled in thirteen shallow grooves.

1694. Nuremburg had a gun forged and rifled, which was tested on several occasions.

1696. The elliptical bore was known, and had been tried in various parts of Germany.

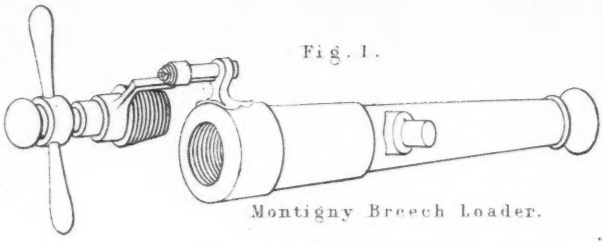
1745. The date at which Robins was experimenting in England, the Swiss already possessed small rifled pieces.

1746. Munich had a rifled breech-loader made, and T. Senner was engaged in rifling various guns.

1816. Reichenbach rifled a bronze gun with seven grooves. This piece is still in possession of the family in Bavaria, and has been fired with pointed leaden balls.

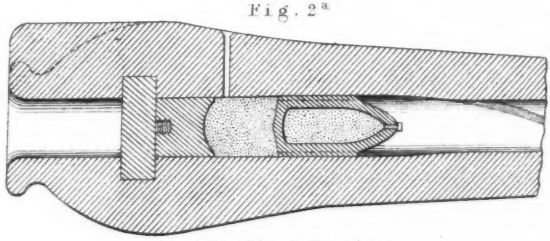
1816 to 1819. M. Ponchara, a distinguished French artillery officer, was making various experiments with an old gun which he had rifled with thirteen grooves.

Fig. 1.



Montigny Breech Loader.

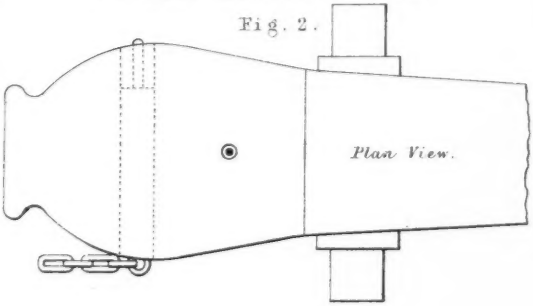
Fig. 2ª



Longitudinal Section.

Cavalli Breech Loader.

Fig. 2.



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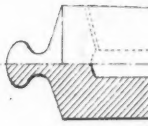

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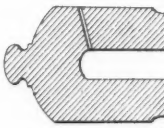

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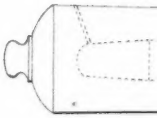
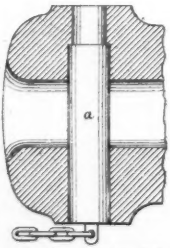


Fig. 3.

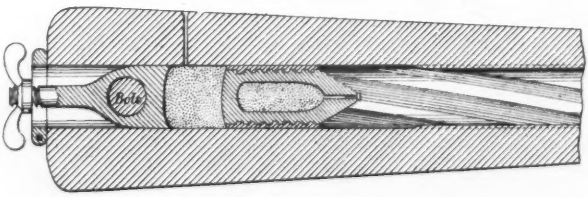
Cavalli Projectile

Fig. 4ª



Section shewing Bolt a.

Fig. 4.



Wahrendorf Breech Loader.
Longitudinal Section.

C H E S .

Austrian 24 Pf Howitzer

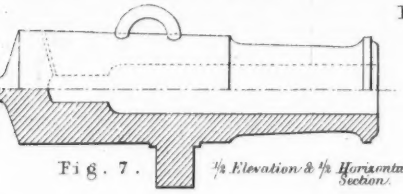
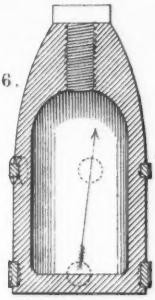


Fig. 7. ½ Elevation & ½ Horizontal Section.

Fig. 5.

Timmerhans Wad & Shot

Fig. 6.



Treuille de Beaulieu Projectile.

Russian 56 Pf

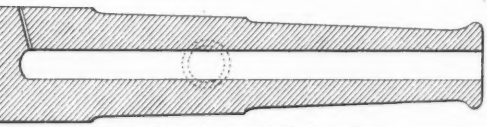


Fig. 8. *Longitudinal Section.*

Russian 120 Pf

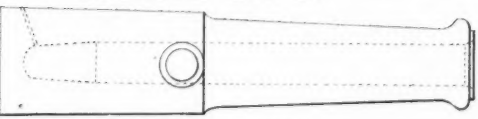
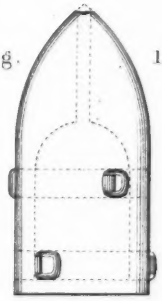


Fig. 9. *Elevation.*

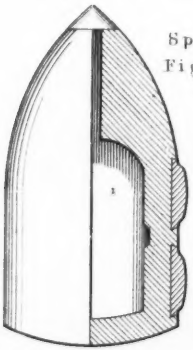
Fig. 11.



Russian Projectile

Spanish Projectile

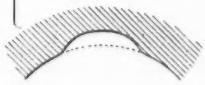
Fig. 12. Fig. 13.



½ Elev.n ½ Section.

Transverse Section

Fig. 10. Russian Rifling



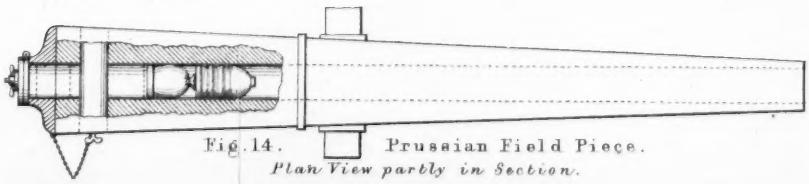


Fig. 14. Prussian Field Piece.

Plan View partly in Section.

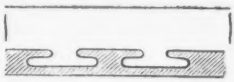
J.R.Jobbins.

1833. Montigny of Brussels invented a breech-loading rifled piece, and the Belgian government had a gun made on his plan. The arrangement of the breech apparatus was simplified in 1835.

1836. The late Emperor of Russia, Nicholas, sent for the inventor, and ordered breech-loading guns of 18 and 24-pound calibres to be made and rifled on Montigny's plan. 1,800 rounds had been previously completed in his presence from a 12-pounder. When these guns were prepared 262 shots were fired in one day from the 18-pounder, and 100 shots continuously on successive days from both the 18 and 24-pounders, and neither wad nor grease was used. But the commission presided over by General Samarakoff rejected the plan. (Plate I., fig. 1). After this, Montigny, the son of the former, went to England, but his applications for an extended trial were unsuccessful.

1845. Major Cavalli, a Sardinian officer, commenced his experiments on rifling, and these seem to have inspired Wahrendorf with a similar aim. Cavalli used a copper ring for closing the breech-joint, and he also tried a copper tube in the breech of his gun, which was rifled with two grooves for a plain iron shot. (See Plate I. figs. 2, 2a, and 3).

1846. The Swedish Baron Wahrendorf, before mentioned, affixed lead to the side of elongated projectiles mechanically, *thus*, and used a gun rifled with shallow flat grooves.



1847. Major Cavalli rifled an 8-inch gun, and attained good results, until the copper breech-ring was blown out. The breech of the gun subsequently gave way, just as happened in his later experiments in England.

1851. Wahrendorf's plan of coating the shot with lead was tried at Berlin with a 12-pounder rifled in six grooves, and a slow twist. The shells for this experiment were cast with two long and four short projections or studs, over which the lead coating was run. Wahrendorf also rifled guns with two grooves on a plan similar to that of Cavalli, but the lead coating, his own peculiar plan, was preferred by the Prussians. In Sweden, however, Wahrendorf's own country, the officers generally were opposed to the lead-coated or forced-ball system (so called from the projectile's outer surface of lead being larger than the bore, which necessitated loading at the breech), and a lieutenant in the Swedish navy named Engstrœm affixed hard wood bearings or buttons to an iron projectile. This plan was tried against Wahrendorf's lead-coating system, but nothing transpired as to which had the advantage, until, in the Annals of the Swedish Academy of Sciences, which were published in 1859, the preference was accorded to the Engstrœm system. Both plans were afterwards tested in France in 1857 by order of the Emperor Napoleon, but neither seems to have been considered as a great success. (In Plate I. figs. 4 and 4a, is shown the Wahrendorf gun.)

1856. General Timmerhans, of the Belgian Artillery, invented a wad which, by taking the rifle-gooves, gave rotation to elongated shot. His guns were rifled with two, four, and six grooves, with one turn in 18 feet, but the results were not sufficiently good to cause an adoption of the plan, which is shown in Plate I. fig. 5. Indeed every system that has been tried,

which does not give rotation to the ball from grooves in the bore, has failed in such manner as to show the impracticability of beneficially applying any other arrangement than that of rifling both gun and projectile.*

Not only plans of rifling, but also systems of breech-loading, have been continually brought forward, which have been sometimes identical with, and at others trifling modifications from, those of more ancient date; and it is also a fact that nearly every modern plan of grooving was used at least 250 years ago in muskets which seem to have been fired with round leaden balls. These necessarily gave little accuracy, and hence rifling did not supplant the smooth bore for muskets until an elongated ball was used, and it has not yet caused the smooth-bore great gun to be set aside. It should however be remembered that the mechanical fit was unknown in the early age of rifling, and it has been reserved to Mr. Whitworth to be the pioneer in the path of shaping the shot so accurately as to centre itself in a grooved gun. M. Cavalli certainly made very good practice with an iron shot, but this was from its tight fitting, which necessarily, like Wahrendorf's plan, required a breech-loader; but it was not until the precision of Mr. Whitworth's guns became known, that great accuracy from muzzle-loaders was regarded as even possible.

Breech-loaders—Wahrendorf and Cavalli.

The first breech-loading gun upon record was used by the English (and on this account I mention it) in 1428 at the siege of Orleans, but whether made in England or not is uncertain. France very early made breech-loaders, and her museums, as well as those of Strasbourg and Bavaria, contain breech-loaders of very early date, and in England there is also a large collection of foreign guns.†

Passing over, however, the breech-loaders of former years, it may be remarked that, in later days, not even the experiments of the elder Montigny, successful as they were, nor the later improvements of his son, succeeded in bringing breech-loading into general use; but, in 1842, Wahrendorf brought forward a plan which for simplicity and strength is still unrivalled. It consists of a round bolt passing through and across the breech, and supporting a valve from which a handle extends to the rear of the gun. When the gun is to be loaded, the bolt is withdrawn, and the valve pulled out by its stem or handle; and, when this operation is completed, the valve is pushed in, and the bolt shot across behind it; and they are then set tightly together by the turn of a screw upon the handle, which projects out of the rear of the gun. (Plate I. fig. 4). The effect of the discharge is to push the valve more tightly against the bolt, and the greater the force of the explosion the more is the valve itself extended. Even should an escape of gas occur, which is unlikely, no great damage can

* In preparing this account of foreign ordnance, the author has met with considerable difficulties, for so little is generally known that even the descriptions of otherwise credible eye-witnesses cannot be fully relied on, from their not understanding the points in which systems of rifling differ.—R. A. E. S.

† In the Museum on Woolwich Common is a French gun dated 1619, with a moveable vent-piece almost identical with that of the present service rifled guns.—R. A. E. S.

be done; but, in all the experiments, the valve, from being on the principle of the steam-piston, seems to have perfectly closed the breech. The gun of 1842 was designed for firing round shot which were covered with lead so as to close the windage. The plan was tried at Shoeburyness, and on board the "Excellent," but the results came far short of the inventor's expectations. Indeed, cutting off the windage entirely, from which such great results were formerly expected, is now found to be a disadvantage. Wahrendorf subsequently introduced an oblong instead of a rounded bolt for the breech apparatus of his rifled guns, and one of these is now under trial by the Ordnance Select Committee—the Service plan of closing the breech by a screw-stopper, and the later plan of effecting the same object by a pair of wedges, having proved equally unsatisfactory.

Cavalli's plan of breech-loading is very similar to that of Wahrendorf, but the apparatus is less simple. There were several of his rifled guns at the siege of Gaëta, but so many accidents happened with them in the trenches, that, on the bursting of a pivot-gun, which reduced the gun-boat to a wreck, the Sardinians, or rather the Italians, following the example of the French and Americans, abandoned the breech-loading, and are now only making muzzle-loading guns. Thus, while, after more than four centuries of trial, other nations are giving up the moveable breech because it does not unite perfect closing of the breech with the solidity essential for heavy guns, we are still going from plan to plan in the hope of effecting what will, even if successful in closing the breech, be scarcely safe with the heavy charges necessary to give the high velocity of projectile which is requisite for smashing armour plates.

But I must here go back a step to mention one, Treuille de Beaulieu, whose researches, following his previous experience of warfare, have so much influenced the rifling of the guns of European nations, and to whom France owes her present system. Long had he to struggle against opposition, and to bear the contemptuous treatment of his proposals by committees.

In the case of the elder Montigny, we have already seen that, although the Emperor Nicholas invited him to St. Petersburg, and the results were most satisfactory, the committee of the Russian Artillery, after putting all kinds of obstacles in his way, obliged the unfortunate inventor to discontinue his labours in their country; and but for this jealousy, so unfortunate for the Russians, they might have met us at Sebastopol with rifled guns.

French Rifled Muzzle-Loaders.

You will perhaps be surprised to hear that, so early as 1842, M. Treuille de Beaulieu addressed a complete paper on the subject of rifling guns to the French Artillery Committee, who, it is said, had not even the politeness to acknowledge its receipt.

In 1850 this artillery officer again urged his proposal, and this time the Committee, with a little more courtesy, did acknowledge the receipt of his letter, but this was the extent of attention they gave the subject.

Now we have seen first one committee rejecting a system for rifling, which deprived the Russians of a weapon that might have gone far to counteract their disasters in the Crimea, at Silistria, and at Bomarsund;

and we have seen a second throwing aside a plan, which deprived France, during its contest with the Russians, of a weapon that gave such remarkable assistance in their subsequent combats with Austria.

Colonel Treuille de Beaulieu's paper would probably have remained to this day in the pigeon-holes of the French Committee office, had not the Emperor, persuaded that smooth-bore guns were not equal to the requirements of modern warfare, stirred up the question of rifled arms, and led to the production of the artillery colonel's paper, somewhat about the time that Lieutenant Engstrœm's plan was under trial in France. I may here venture to remark, that a despotic prime minister, who, despite committees, and in defiance of precedents, will take upon himself the responsibility of ordering the trial of a system which gives reasonable hope of success, and on a sufficient scale to test its merits, only endears himself the more to the people as a thorough patriot; and, as such, all must esteem Lord Palmerston, and admire his decision for an immediate trial of a battery of Mr. Whitworth's guns. Excuse this little digression, and I will return to Colonel Treuille de Beaulieu, and what he has done for the French artillery.

The French Emperor, after satisfying himself of the superiority of the Colonel's plan over that of Engstrœm's wooden bearings and Wahrendorf's lead, at once rifled some brass pieces, and sent them for immediate service in Algeria. Here their success was apparent, but the guns were considered too heavy, and, on receiving this report, the Emperor rifled his light brass pieces, and thus, at a very trifling expense, France was placed in possession of the artillery which was soon to do such good service in the field. These pieces consumed their usual powder and their ordinary shot as well as fired the elongated projectile, an arrangement that enabled the French to cut up the astounded reserves of Austria when at a distance, and to overthrow their squadrons at close quarters by the unfailing case-shot. The repulse of the Austrian cavalry is worth recording—they had formed in the plain, and were seen from the heights bearing down upon the thinned and wearied columns of the French infantry, when the order "load with case" was given to the artillery, and, as the cavalry dashed onwards, burning to achieve a victory, they were met and rolled over by a shower of canister-balls that sent back many a charger riderless, leaving gaps in their ranks which hopelessly disordered the survivors, and prevented them from again returning to the charge.

The rifling of the French bronze field-pieces that did this execution consisted of six rounded grooves, and the projectiles had twelve zinc studs* or buttons placed in pairs (see Plate I. fig. 6), one stud being arranged so as to push the bearings of the shot tight against those sides of the groove on which it would press in coming out, to prevent an injurious play on the shot's starting. The weight of the gun is about 6 cwt., and

* The French sloped off the bearing side of the buttons to the angle at which they were found to have been rubbed down by the rifle grooves on discharge, and they attributed much importance to the use of zinc; but have latterly discovered that accuracy of adjustment of bearing is alone required. The rubbing down aslant merely showed that the projectiles were not preserved concentric in their passage out of the gun. One of the projectiles fired at Solferino is in the Museum of the Institution, together with various rifle-shot used in England.—R. A. E. S.

that of its rifle projectile 9lbs., and it was this lightness which enabled Tartar ponies to draw the French field-pieces through the marshes of China, in which our own guns of 8½ cwt., and mounted upon heavy carriages, stuck; a defect which is about to be remedied by introducing an Armstrong gun and shot of the same weight as the French.

Besides these field-pieces, the French, after careful trials of the two-grooved elliptical rifling for larger ordnance, gave it up for three centrical grooves in December, 1860, and, as the plan was simple and inexpensive, they at once carried it out with their heavy guns, and were again ready for the contest. The ordnance thus treated were cast-iron 30 and 50-pounders, which were rifled so as, in addition to their usual smooth-bore ammunition, to throw shells of 60 and 89lbs., containing 5½ and about 8lbs. of powder respectively. These guns were strengthened by hoops put on the breech. (*Vide* Captain Blakely's Lecture, vol. iv. p. 401 of the Journal of the Institution.)

The projectiles, instead of having twelve studs wholly of white metal, were fitted with three large studs, one half of which were of zinc, and the other half cast on the shell. (See vol. v. page 434, plate ii. of the Journal). The rifling of the gun commences from straight, and increases gradually in quickness of turn from breech to muzzle, the object aimed at, being to allow the projectile to move easily at the first impact of the charge, so as to lessen the strain upon the breech. This is, in my opinion, a mistake, for the studs strike the sides of the rifling very hard, which, besides wearing down the edges of the grooves, breaks off portions of the studs, occasioning an erratic flight to be taken by the ball. These studs are also liable to injury from carriage, and flattening by a fall. In both cases there might be a difficulty in loading, and they are not safe for firing over ships or advanced works.

In the cast-iron service 32-pounder, which was rifled on the French plan, and tried at Shoeburyness, the zinc was put upon the wrong side of the button, so that in loading the zinc pressed against the grooves, and, on coming out, the iron came in contact with them. The consequence was, that, in 40 rounds, the iron had knocked away the edges of the bearings of the grooves, and rendered the gun unserviceable; but, despite these disadvantages, the practice so impressed one of the competitors, that he said, "Well! that *is* a good plan!" and, as his own gun was in trial, we may take what he said as of some value.

In addition to these naval guns, the French have some light brass mortars, which are likely to prove useful for dropping shells upon the deck and into the engine-room of a foe.

Austrian Rifling.

The Austrians, taught the value of rifled pieces at Solferino and Magenta, must be admitted to be not bad judges of the worth of the French plan. Their first trials of rifling commenced about 1857, and were continued through 1858 and 1859 without any decision being arrived at; but, on the 4th April, 1860, after some previous experiments, breech and muzzle loading rifles, and lead-coating and French studs, were tried against each other. On this occasion the Emperor was present, and a

unanimous decision was given in favour of Treuille de Beaulieu's plan, because—

1st. It could be quickly and cheaply carried out.

2ndly. It united facility of fire with sufficient accuracy.

3rdly. It combined in one piece the advantage of the gun and howitzer.

4thly. It allowed of the employment of all the existing material.

But mark, Austria is not satisfied that she possesses the best gun, and, since February, 1861, has been making trials of three systems of rifling. She is also making experiments with a new metal for ordnance, and has lately obtained excellent results from gun-cotton, which has been fired from short and thick-chambered pieces of bronze. (See Plate I. fig. 7.)

Austria, like France, Spain, and other countries, has made trials of finely-grooved breech-loaders on a plan similar or analogous to that adopted in this country, and did intend in 1859 to cast breech-loaders at Marcazell, but decided in 1860 that any advantages in accuracy from centering the projectile on so many points was more than counterbalanced by the greater delicacy and expense of lead-coated shot, and the want of solidity resulting from a breech-loading plan.

Russian Rifling.

The Russians are now endeavouring to make up for lost time, and to rifle the heavy ordnance, mounted on their various fortresses, on a plan similar to that of the French. They have already purchased portable rifling machines from Messrs. Vavasseur and Co. of London, with the intention of grooving the guns without moving them off their carriages; and they also mean to use the rifling machines in a similar manner on board some of their ships; but their larger guns*—120-pounders of 10¾ inches bore, firing a hollow shot of 120lbs. (the solid would be about 160 lbs.) and the 56-pounders, which are like the American columbiads—they now intend to rifle. (These guns are shown in Plate I. figs. 8 and 9.)

The Russians had rifled several of their smaller fortress guns (30-pounders and 24-pounders) with six grooves, and their field-pieces have been mostly rifled in a similar manner, but, instead of placing the studs in pairs, and having twelve of them, they use only six placed alternately. Their rifling has an equal twist, and the grooves are slightly narrowed at the bottom. In the field-piece they are sloped off on one side to allow the projectile, the bearings of which are also sloped off, to wedge itself tightly; but these slight modifications, which have been also tried in France, possess no advantage over the fittings adopted for the French service. (See Plate I. figs. 10 and 11).

Swedish and Dutch Rifling.

In Sweden, Baron Wahrendorf's own country, Lieutenant Engstrœm's

* These guns are, it is believed, to be strengthened at the breech by hooping, and may then be rifled in three grooves to fire a projectile with long iron bearings instead of studs, as the Russian trials with this plan have been satisfactory. An officer was lately in England gathering information respecting the English experiments with iron shot.—R. A. E. S.

system was preferred; but the French plan is considered still better, and is the one now used.

The Dutch have also preferred the French system of rifling and have applied it to bronze guns. The reasons for this almost general adoption are given in very similar terms to those made use of in France, viz. that M. Treuille de Beaulieu's system was—

The simplest;

The quickest and easiest to carry out;

The cheapest, and involved no complications.

Spanish Rifling and Strengthening for Cast-iron Guns.

The Spaniards rifled their field-guns on the French plan, and used them against the Moors at the siege of Tetuan, and—as an author, M. Mangeot, whose researches I have largely availed myself of, states—"taught the Moors by improved weapons the advantages of civilization."

Their heavy guns have, like the French, been lately rifled with three grooves, the only difference being that the twist of the rifling is uniform, and that the projectiles have studs in pairs instead of one large stud only for bearings. (See Plate I. figs. 12 and 13.) Spain has also followed the example of France in hooping her heavy ordnance, having previously ascertained that the unhooped cast-iron guns rapidly deteriorated, and ultimately burst at less than 200 rounds, but that the hooped guns, when properly fitted, which was arrived at by careful experiment, always stood more than 1000 successive discharges.

The final decision of the Spanish Committee is thus given: "The path we must follow is clearly indicated,—cast-iron cylinders hooped, a most simple manufacture, which, once established, only requires great care in securing the proper diameter to the bore of the hoops. The difference between the diameters of the hoops and of the cast-iron part must be determined by experiment aided by calculation."

Sardinian Rifling.

The Italians made several trials of Cavalli's system of rifling in two grooves at Turin, and ultimately decided that the ribs on his shot were unfit for field-pieces. These ribs projected too far for the size and weight of the shot, and consequently stopped the rotation, and materially lessened the range. The tightness of fit was found also to be a serious objection to using the plan for muzzle-loading.

At the siege of Gäeta many of the guns used were grooved on the French system, and some threw zinc-ribbed shot similar to those used in the Armstrong shunt: but the guns for these last, and a crowd of various small calibres of guns, were gradually suppressed, Cavalli's and Wahrendorf's systems abandoned, and breech-loading entirely given up. The "Revista Militare" of Turin, dated 1859, contains, according to Fourcault, a full account of the failure of the breech-loaders, and states that the accidents which happened had been fully anticipated, the plan being unfit for heavy guns; and thus the Italians, having first adopted the French plan for field-pieces, now took it in its entirety for heavy guns also.

Prussian Rifling for Cast-iron and Steel Guns, and Belgian Rifling and Bessemer Metal.

But are any nations using the lead-coated shot? Yes; the Prussians, who first adopted breech-loading and a compression plan.

They have had a large number of steel field-pieces made by Krupp of Essen; these weigh 800lbs. and throw projectiles of 13lbs.; but their heavier guns are cast from charcoal iron of a very superior quality; but mark, with these rifled guns the Prussians have retained several smooth-bores, so as not to lose the advantages of the straight ricochetting and rolling of the round ball. Their field-gun is given at Plate I. fig 14.

The Belgians also, impressed by the accounts of the immeasurable superiority of the English rifled piece, and influenced by Prussia, seem to have very lately decided upon lead-coating, but have wisely adopted a slight modification of Wahrendorf's plan of closing the breech; this differs from the Armstrong in that, while a little extra pressure forces the breech-stopper (vent-piece) of the latter away from the end of the bore, causing a dangerous escape of gas, the valve face of the Wahrendorf stopper is only more fully expanded and the stopper more tightly pushed against the bolt which supports it in the bore of the gun. [Shown by a model on the table].

The Belgians are also testing Bessemer's steel for rifled guns, and have, as far as their trials have gone, found it to be a very superior metal; and, as it can be produced at comparatively small cost, they will probably largely employ it.

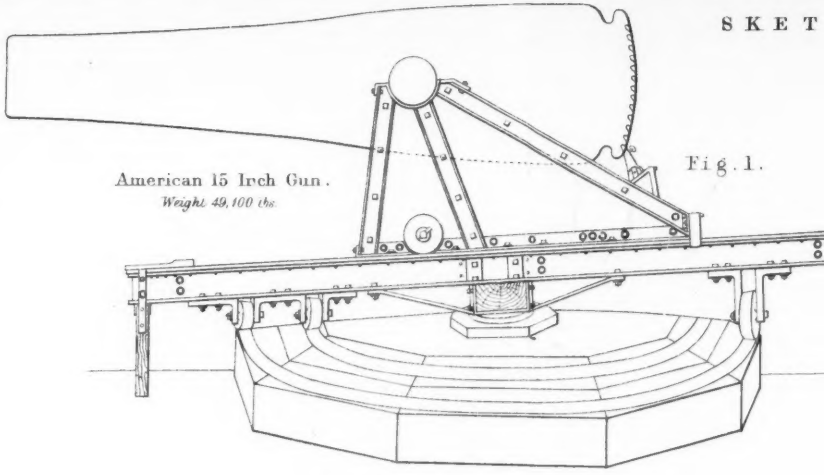
In England, Bessemer's own country, his metal has not yet been tried by Government, but it was used in one of Mr. Whitworth's guns.

Portuguese, Swiss, and Egyptian Rifling.

Not to fatigue you by further details of the guns of European countries, I may mention that, besides the nations spoken of as having preferred the French system on account of its simplicity, its allowing of the use of the old ammunition, and combining the advantages of the smooth-bore and rifle,—the Portuguese, the Swiss, aye, even the Egyptians, have, after careful trials, condemned breech-loaders and delicate projectiles as unfit for the rough usage of war, and have followed the safer plan of rifling their present guns and using elongated shot as well as all their present ammunition.—(Fourcault, "Le Canon Prussien," edition of 1861).

American Large Iron Guns, cast hollow.

But it is time to go across the water to the Americans and to examine what they have done. You must all have heard of the Dahlgren and Columbiad guns. The former is in shape very like a soda-water bottle, being much rounded over the breech; the latter is rather a straighter gun; but of the large weapons, which alone seem to be in favour in the States, their 15-inch-bore guns are the most in favour. (*Vide* Plate II. fig. 1.) The gun represented was cast hollow at the Pittsburg foundry, under the direction and after the method of Captain F. J. Rodman; it weighs 49,100lbs., and is 165 inches long in the bore; the thickness of metal

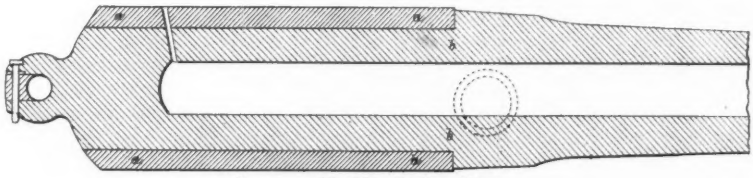


American 15 Inch Gun.
Weight 49,100 lbs.

Fig. 1.

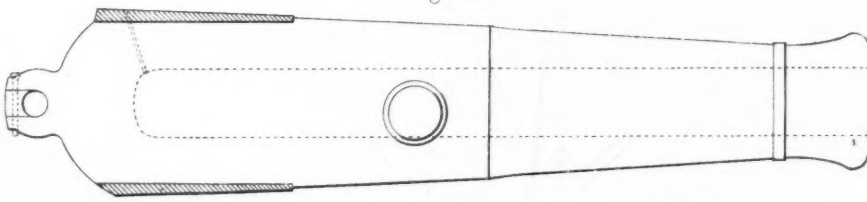
Fig. 3.

Armstrongs Cast Iron Hooped Naval Gun.



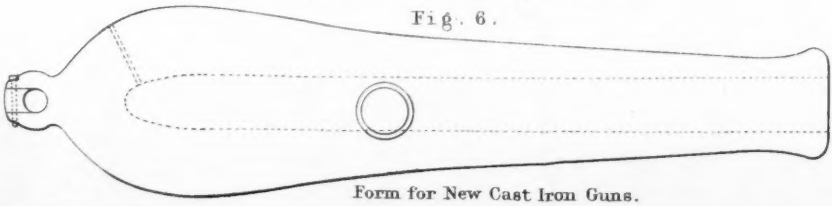
a. a. Space covered by Wrought Iron Hoops.

Fig. 4.



Side Elevation of Cast Iron Gun, *shewing mode of strengthening by Wrought Iron Hoops tried in England 1861.*

Fig. 6.



Form for New Cast Iron Guns.

S K E T C H E S .

Fig. 2.

g. 1.

Section. Parrot or Blakeley Gun.

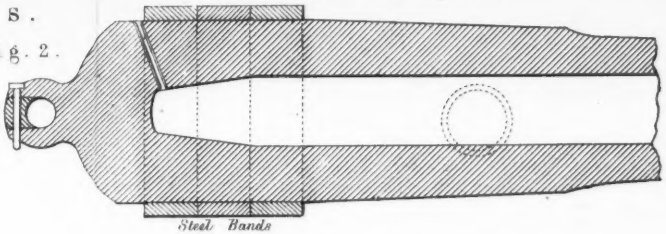


Fig. 5.

Horizontal Section of 13 Inch Sea Service Mortar.

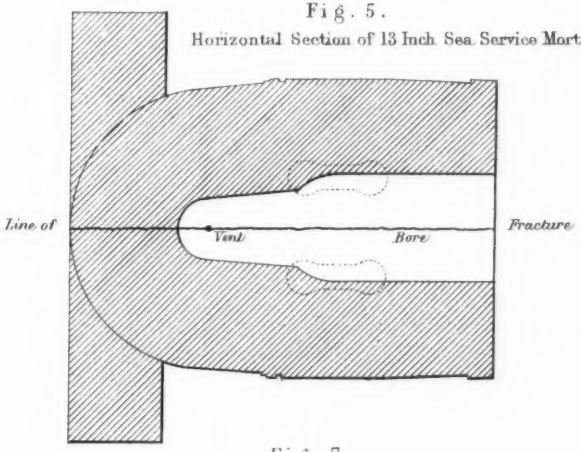
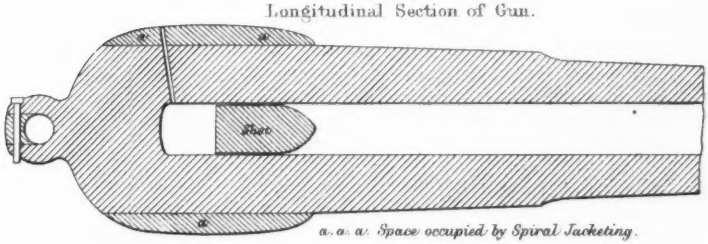


Fig. 7.

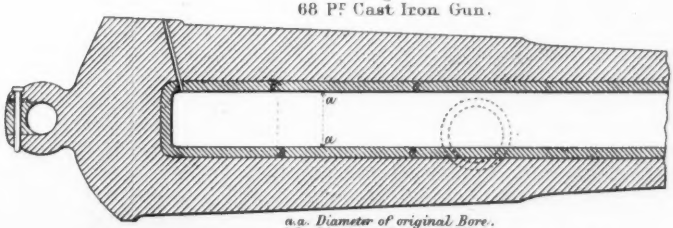
Longitudinal Section of Gun.



a. a. a. Space occupied by Spiral Jacketing.

Fig. 8.

68 Pr Cast Iron Gun.



a.a. Diameter of original Bore.
b.b. Diameter of enlarged Bore.
c.c. Wrought Iron Tube, occupying space bored out.

J.R.Johnns

through the sides of the gun at the junction of the bore with the chamber is 16½ inches, and the thickness of the metal at the muzzle 5 inches.

This gun had fired 350 rounds before the middle of last year with shells weighing from 305 to 335lbs., and an average charge of 35lbs. of large-grained powder; it was worked with facility, requiring from 1′ 10″ to 1′ 52″ to complete loading, running out, training, and firing.

At 6° elevation, the shot struck the ground at 2017, 1937, 1902, 1892, and 1873 yards; the lateral deviations being 1, 3, ¾, 5 yards to right, and 5 yards to the left. The time of flight was from 6½ to 7 seconds. The initial velocity was found by experiment to be 1328 ft. per second with 40lbs. of large-grained powder, and 1282 ft. per second with 50lbs. of perforated cake.

At 28° 35′ elevation, the range of this gun with shell of 334lbs. was found to be 5,200 yards with 50lbs. perforated cake, and 5,400 with 40lbs. of large-grain powder; the time of flight being about 27 seconds.

The large-grain powder used, differed from common powder only in the size of the grains, which are $\frac{6}{10}$ inch cube, and in the degree of pressure to which it is subjected in manufacture.

The perforated-cake powder, invented by Rodman, is prepared in solid compressed cakes (subjected to a pressure in the making equal to what they will be subjected to in the gun), and perforated with holes to permit access to the flame; it is intended to reduce the excessive strain to which very large guns are subjected with fine-grained powders, which are inflamed almost instantaneously, and before the heavy projectile is started from its seat. This was ascertained by the "pressure gauge" attached to the gun, or introduced into its chamber; and the comparative initial pressures of "perforated cake," "large-grained," and common cannon powder, were thus found to have about the ratios of $\frac{1}{7}$, $\frac{1}{3}$, and unity. This, writes Major J. Barnard, of the U. S. Engineers, is a result of very great importance in its bearing upon the practicability of using cast-iron guns of extraordinary calibres.

Speaking of rifled guns, Major Barnard says range and accuracy are of little value unless the projectile possesses the necessary destructive qualities. And again, "to damage a vessel seriously it is not the hole-punching property which we need; it is the smashing effect, the staving in of planking and timber; or, if a hole alone is made, that it shall be so large as to defy plugging."

The Americans are abolishing 24 and 32-pounder guns, and substituting Columbiads and Dahlgrens, rightly considering that such small-bore guns will be of little use in a future conflict. The early guns had a large chamber of less diameter than the bore itself, but this was found very objectionable in practice, as the shortening or reducing of the charge left an air-space which endangered the safety of the gun. During the last war with England the Americans used a very thin metal instead of flannel to cover the powder, in order to prevent the necessity of sponging at close quarters; and they have lately succeeded in making their powder water-proof. Another of their plans is to cover their old round shot with pulp to reduce the windage, which is, even in the 15-inch gun, only $\frac{1}{10}$ of an inch; we, however, foolishly continue to give a windage which was necessary some

50 years since, when balls could not be cast truly spherical, but which with the exactness of the present castings, under the very able superintendence of the head of the Laboratory Department, could be now advantageously reduced by one half.

American Strengthened Rifled Guns.

The Americans have rifled their field-pieces, and have been rifling some of their heavy ordnance; the "Parrott" gun is merely a cast-iron piece rifled and then strengthened by hoops on the Blakely plan. (See Plate II. fig. 2.) The Times' Correspondent writes thus: "The Parrott gun, made by the eminent founder at West Point, is a simple workmanlike-looking piece of artillery, with a thick iron band shrunk over the breech, and its range is nearly as great as that of the Armstrong, and its cost very much less;" and again, "Captain Dahlgren informed me he was surprised to find we were content with iron in our guns of such inferior fibre;" and also, "in the qualities of iron the Americans say our standard is much lower than theirs."

This opinion seems to be borne out by the unequal expansion of the cast-iron guns which were lately attempted to be strengthened by tubing (see page 18), when the bending, on heating, occasioned the destruction of two guns before one could be successfully tubed; and in the English work on "The Useful Metals" it is stated, at page 213, that "The quality of our pig-iron has deteriorated within the last half-century. In an English gun imported into America in 1845, the cast-iron was of a density of 7.04, and tensile strength of 18.145lbs. to the square inch; while other English guns, imported about thirty years previously, contained metal of a density of 7.202, and tensile strength corresponding to 28.067lbs. to the square inch."

The Americans have invented many breech-loaders, and amongst others a plan which they supplied to this country, at a cost, of, I believe, 10,000*l.* including the six guns and patent. These six guns are still lying near where they were landed in the Arsenal, quite unfit for use; they are rifled with several shallow grooves similar to those used by Prussia, and were intended to fire lead-coated shot.

The Americans, however, carefully eschew the use of breech-loaders, though they seem to have been at first favourable to compound projectiles. The Southern Confederacy has purchased very many of its heavy guns from England, which, with few exceptions, fire lead-coated shell. At the cannonading against Fort Pickens, these leaded projectiles struck on their base, which was heavier than the front, and did not explode; the range obtained was, however, sufficient to show the value of rifled weapons, for the smooth-bores mounted in Fort Pickens were unable to reply to the distant bombardment.

The value of rifled guns was equally shown in the chase of a small Confederate steamer by the North American frigate "Minnesota;" for the former pitched several rifle shells upon the latter's deck, causing very serious damage, and some loss of life, while keeping quite out of reach of the latter's smooth-bore guns.

It only remains to add, that the Americans have rifled their field-pieces,

and are reducing their guns to as few calibres as possible, following in this the example of the French, who are, it is said, bringing the mass of their ordnance to 4 calibres, viz., 1 for the field, 1 for the siege, and 2 for naval purposes, viz. 30 and 50-pounders; and this wise plan is also being followed by Austria and Sardinia.

Having thus examined what continental nations and our cousins across the Atlantic are doing, it will be well to compare our own progress with what they have effected at so small an amount of effort and expense: in fact, foreign countries have, for the most part, given to their old guns by rifling a very great increase of range, and obtained greater effect by the use of elongated shells, still retaining the use of their former ammunition.

English Rifles; Solid Round Shot and Shell Guns.

England, however, unrivalled in resources and in manufacture, has adopted a new gun, and with it a principle of rifling, which cannot be applied to her old artillery; she is therefore, like Prussia, obliged to retain smooth bores, and thus to have two guns to perform the work of one; and, while most other countries are reducing the various kinds of ordnance to four or six sizes of bore altogether, we have already seven or eight small calibres and about 20 varieties of Amstrongs, in addition to as many or more different diameters and descriptions of smooth-bore guns. Awakened, as we were, from our complacency respecting the old ordnance, we have very much over-estimated the effects which would be produced by rifled ordnance, and hence have neglected the improvement of our cast-iron guns; and, as the Armstrong system could only be applied to specially constructed weapons, the smooth-bores were at first virtually put aside, being regarded by those who had little experience of warfare with something approaching the contempt entertained for "Brown Bess." This did not, however, lead to stopping the supply of cast-iron ordnance, and we have continued to receive shot and also *shell* guns, which answered well whilst the round ball and the round shell were alone fired, though, even then, the larger guns were barely strong enough (from being cast of bad form and solid instead of hollow); but now that round balls are only valuable within 600 yards against plated ships, and shells of little or no use against them, their form, size, and mode of manufacture, are evidently unequal to the requirements of modern warfare.

English Plans for Strengthening Cast-iron Guns; Casting upon a Core; and Remarks upon English and French Rifling.

In manufacturing the new artillery, difficulties soon arose, and it likewise became evident, that the force required to squeeze a leaded ball through a barrel of smaller size than itself threw a strain upon the weapon, which increased in a very rapid ratio as the size of the bore increased. The shunt method of rifling had been tried with a cast-iron service 32-pounder in 1859, and this gun bursting at the 50th round, indicated that an increase of strength was necessary, and therefore "hooping," which had been proved a success when applied by Captain Blakely in 1856, was again resorted to.

Instead, however, of hooping the existing ordnance on a plan which had proved successful, a new pattern weapon, which was thick in front of

the trunnions, and very thin at the breech, was supplied. (See Plate II. fig. 3.) But as the hooping, *a a*, did not unite the cast-iron to the wrought-iron bands, the weapons had so little longitudinal strength, and were so weak at *b b*, where the thickness of cast-iron was suddenly reduced 2 or 3 inches, that the guns proved unsafe.

The next plan tried was that of casting gun-metal upon these iron weapons; but the molten brass, after *burning* the iron it was thus cast upon, proved to be so yielding, that the iron breech burst and opened about an inch without any (apparently) great strain being thrown upon the brass. Captain Blakely was then permitted to try to utilise these new iron castings, and his method has hitherto stood the proof, in the only gun altered by him. Subsequently, a plan of binding the breech to the rest of the gun was tested, the piece being cased in wrought iron, and bound together by longitudinal bands attached to its trunnions; but the results were very disproportionate to the expense. The mistake of trying to hold on the breech longitudinally has arisen from the gun's breaking against the thick breech on bursting; but it is in reality first fractured at the seat of the shot, and then flies open, breaking off the pieces on each side. A cast-iron gun goes gradually, of which indications are generally given by minute cracks, which gradually enlarge, but can only be seen round the vent hole. Another plan of strengthening was that attempted by inserting a tube of steel or wrought-iron inside the larger cast-iron ordnance which were proportionately bored out; but the difficulty of getting the proper amount of tightness, the weakening of the gun where the tube abutted against the bottom of the bore, and the fact that if put in without damaging the piece the tube might crack and the gun burst without warning, will always render such a method as unsafe in practice as it is difficult and expensive in its application (see Plate II. fig. 8). The last plan of strengthening tried is that shown in Plate II. fig. 4, but, as the thickness of the wrought iron was at the breech end, no advantage resulted from its employment; and thus, strengthening cast-iron guns has been pronounced a "fallacy," and, as it appears, is definitely condemned. The Armstrong gun itself is, however, a proof to the contrary, and affords an example of the union of two different irons, (the grain of the one crossing the grain of the other,) yet resulting in giving that strength which was found unattainable prior to the use of the forged breech, to which the coil tubes are welded: another example was afforded by Captain Blakely's strengthened gun, which was fired at Shoeburyness in 1856, and threw 2,389 shot, whilst 479 shot only were fired from a brass piece before it was disabled, and 351 and 137 respectively from two unstrengthened cast-iron guns before they burst; the powder charges being very great in all four cases.

It has been stated that the French ordnance is not stronger than before it was hooped; it is possible that this might appear true under a similar test to that used in England, which consists in increasing the weight of the proof-cylinder by the weight of one of the gun's shot every 10 rounds (by which means the strain is made to act in a different manner and direction to that thrown upon the gun when firing the proper service charge); but it is not true as respects the ordinary endurance, which is rendered much more uniform and continuous by hooping.

I may remark, that all guns properly cast are sufficiently strong to resist a few rounds of very heavy charges, but by using them the particles of iron would be disturbed, and then would not re-arrange or re-settle themselves unless a long period of rest were given.* With smaller charges, cast-iron guns slowly deteriorate with constant use, but they become very rapidly weakened if fired continously, so much so, that, were a gun to be fired rapidly for 300 or 400 rounds and then proved with a heavy charge, it would almost inevitably burst. The object therefore to be aimed at is, to prevent the disturbance of the particles, and the consequent deterioration of the piece; and this is what the hooping *does* effect, when the gun is fired with the charges which the hoops are calculated to withstand; should a greater strain, however, be thrown on the gun, the hoops first become strained, then break, and the cast-iron, relieved of its supports, goes also.

These hoops, if well manufactured, will give very great support to the gun from the strain upon them being "tensile;" this will account for the success of the Spanish experiments in strengthening, in which the hooped guns withstood 1,200 rounds uninjured, while similar unhooped pieces burst in less than 200 rounds.

The guns tried in Spain were all 32-pounders, which were rifled on the plan previously described, and fired with about 7lbs. of powder and projectiles weighing 60lbs. Unlike a smooth bore, in which the ball rolls over and starts at once, rifling, besides weakening the gun in proportion to the depth of the grooves, greatly increases the strain by detaining the shot; and it is the lengthened period the breech has to withstand the great pressure, resulting from the reduced windage, the detention of the shot, and the combustion of a larger portion of the powder charge before the shot starts, which is so destructive to the endurance of rifled cast-iron ordnance.

It is undoubtedly true, that a more fibrous structure than is to be met with in the present cast-iron, is required for powerful rifled guns; but we have so greatly neglected to make the best use of cast-iron, that both our guns and our mortars have been cast of a form which is not only weak, but also tends to their destruction.

* Many experiments have shown the destructive effects on cast-iron ordnance from continuous firing, as also the increased strength resulting from long rest; and, by allowing two or three months or more to intervene between the series of discharges, a very much greater number of rounds may be safely obtained than in the case of almost daily practice with the same gun: the endurance is also much affected by firing at high elevations, at which the weight as well as friction of the shot has to be overcome, and little or no relief is afforded by recoil. At page 218 of the work on "The Useful Metals," published in 1857, it is stated that "pieces cast some years before testing stood several times the quantity of firing of other pieces cast but a few months previously." The tensile properties of the metal did not explain the difference; and the form, dimensions, weight, method of casting and cooling, and the manner of proving, were the same in all the pieces tried. Casting hollow, or, as it is termed, upon a core, instead of solid, very materially increases the strength and the endurance of guns, and is, therefore, always used by the Americans for heavy ordnance. In England we have likewise had similar results, for while there is, it is said, no record of any 13-inch mortar bored out from the solid, standing 700 rounds, there are at the present moment two mortars in the Royal Arsenal which were cast hollow, and have respectively withstood 2,000 discharges.—R. A. E. S.

Mortars.

The effect produced by this faulty form was seen in the bombardment of Sweaborg, when nearly the whole of the mortars employed either burst, or were rendered unserviceable; the best, that of the "Growler," cast in 1813, standing 355 rounds only.

By a reference to the drawing, it will be seen that the trunnions prevent the expansion of the iron at the places where they unite with the piece; hence, as the iron warms, it expands at the bottom, and the mortar being supported upon its trunnions, a severe shock is thrown upon that part which is in the line of least metal, and has been further weakened by expansion; the result is, a gradual disturbance of particles and rapid deterioration, until at length the mortar opens and generally splits in two pieces, much as if chopped down by some instrument. (See Plate II. fig. 5.) An inspection, however, of the remains of the mortars will afford convincing proof that some cause was at work to produce such very similar results, and will show how little our mortars are to be relied on for continuous bombardment. The mortars might, however, be strongly hooped at the breech, and then they could be rifled so as to throw incendiary shells of very great capacity.

Doubtless the placing of the trunnions at the re-inforce would greatly increase endurance and give other advantages, but the solution of this important question is now to be looked for in short and comparatively light rifled guns of large calibre, to fire elongated shells of very great powder or molten iron capacity, either horizontally or at mortar elevations.*

Destructive Effects of Air Space in Guns.

Having thus endeavoured to show the faulty shape of our present guns and mortars, and that no plan affording reasonable ground to hope for success has yet been applied for strengthening them, other than that proposed by Capt. Blakely, which proved successful, I may now mention, in proof of the little attention paid to the improvement of our heavy naval guns, that, although the bore has been constantly observed to have been expanded near the seat of the shot—in reality between the powder and shot—the cause was not known until the "proof" of the Sardinian ordnance. It was then found out, owing to the damage done to so many of the guns; and, as a very thick wad was used, attention was directed to this point; the result was, that the damage was found to have taken place just where the wad lay, and it thus became evident that the compression of the loose wad left a considerable air space, and caused the damage. In the service cast-iron guns, the metal of which is turned down at the seat of the shot, where strength is most required, and are disproportionably

* Howitzers mounted upon rotating mortar beds of modified construction, and supported by elastic rings to absorb recoil, would be especially useful for firing into port-holes, or for sweeping the decks of ships, and the banks and shores of rivers; they might also be advantageously used for dropping molten iron shells upon the unprotected parts of vessels, or into dockyards, &c. At great elevations the rifled howitzer would carry its elongated projectile beyond the present mortar range with less than half the mortar charge of powder.—R. A. E. S.

thick at the breech, the use of a soft wad, or making the rear of the projectile of tapering form, which leaves an air space, greatly diminishes the endurance of such ordnance when "rifled;" hence, in testing the relative strain of different systems of rifling with these guns, it is necessary to use projectiles of similarly shaped base. It had been long known that a wad placed between two shot in a smooth bore caused them to break up, and that red-hot shot which were fired with thick wetted junk wads endangered the piece, but no application was made of this knowledge; there can be little doubt, however, that the "proof" has much damaged our cast-iron guns, and that the system on which both the Armstrong and smooth-bores are tested, and on which all our tests for endurance are conducted, needs considerable alteration. There is a story told of two gun-makers respecting this point. One of them had been sending down his guns to have them proved, and a great number had burst. He asked the other how he managed, that his guns answered so well. He replied, "That is my secret"; but, being pressed to explain the cause, at length said, "I do not prove my guns at all."

Proposed Form for New, and Plan for Strengthening Present, Cast-iron Ordnance.

But it is time to point out the shape that is likely to give good new cast-iron guns, and also the plan that promises to utilise our present stock, and to convert it into rifled ordnance at a moderate cost; but, even if not afterwards rifled, it would be certainly advantageous to strengthen the guns of 8-inch bore; for, in the case of the 68-pounder, a powder charge of 20lbs. or more, and a tighter fitting shot of about 72lbs., could then be projected with a much higher velocity than that obtained by the 68-pounder ball at present used. The *rifle* charge for cast-iron guns should be about half the *round-shot* charge, which would produce about an equal strain up to an elevation of 5°.

With respect to new guns, the form shown at Plate II. fig. 6, is proposed, the piece being chambered to lessen the re-action against the bottom of the bore. This shape will give thickness and rigidity where the strain comes, and prevent the disarrangement of the particles by the great force exerted, tending to pull open the bore at the seat of the shot. The guns will also expand equally on warming, and thus two elements of weakness—unequal strength and unequal expansion—will be got rid of; and, if the length be slightly reduced, new guns of 8 and 10-inch bore could be cast to fire solid balls instead of the present ineffective round shell—which can alone be fired from all the 10-inch and the 8-inch, (except the 95 cwt. guns supplied to the "Warrior" and similar vessels)—without any increase of weight, or any extra cost.

The strengthening of the present ordnance would be best accomplished by a single wide coil or jacket (see Plate II. fig. 7), forced on cold by carefully measured hydraulic pressure, which could be effected at very small expense. The new and the strengthened guns could then be rifled, and fire the elongated projectile in addition to the usual smooth-bore ammunition. This strengthening might be applied to all guns from 18-

pounders upwards, inclusive, by which means rifled weapons would be at once attained at moderate cost; these might, when unserviceable, be replaced by guns of a better material, such as strong hollow forgings, coil-jacketed from breech to trunnions, with a wide hoop over the jacket at the seat of the shot; this arrangement would leave the tough forged muzzle—the exposed portion of the gun—to withstand the blows of hostile shot; or else they might be replaced by hooped castings of Bessemer's steel, a metal which will be probably employed ere long for making shot. Of 18-pounders we have a large number, and it is probable that these, if rifled and strengthened as indicated, would be quite equal to the 40-pounder Armstrongs (the largest guns, next to the 100-pounders, which have hitherto proved sufficiently satisfactory to be manufactured in large numbers) for ship use. The bore of the 18-pounder is considerably larger than that of the 40-pounder, which would be advantageous; and the expense of its rifle projectiles would be only perhaps a third of those which have been supplied for the Armstrongs, and the cost of its round ball perhaps not more than one-fifth that of the solid 40-pounder Armstrong shot.

Armstrong Guns—Whitworth and Armstrong Competition.

Having thus endeavoured to show the small reliance that can be placed on our mortars, how the present guns can be utilized, and new strong guns cast, it remains to speak of the Armstrongs, which are being introduced into the service so fast as to bid fair to supplant the cast-iron pieces. These guns are made up of coils which are not adapted to withstand blows from hostile shot, and they are grooved too finely to stand exposure and rough usage, or to fire any other ammunition than the lead-coated projectiles specially designed for them. The calibres vary from a bore which is a little larger than a 2-pounder to one larger than a 42-pounder, or, as usually denominated, from 6 to 100-pounders. Of these, the 12-pounder field-piece is to be replaced by a 9-pounder for the horse artillery, which will give two weights of shot, viz. 9 and 12lbs. for the same field-work. In the Chinese campaign the 12-pounder was found too heavy for the marshy ground, nor was its destructive effect commensurate with its accuracy of fire. Sir Robert Napier's dispatch, given in the Times of November 5th, 1860, speaks of the Tartars advancing on more than one occasion despite our fire, and it is said that Desborough's troop alone prevented the sabring of the gunners who were working a couple of the Armstrongs. On board ship, the guns have hitherto proved to be dangerous, requiring a caution which is impossible in any case save in target practice, or very distant firing; and the guns have been also found to be inaccurate if at all corroded by rust, or if mounted upon a quickly moving platform. Contrary to what is generally believed, the competition between the Armstrong and Whitworth 12-pounder strikingly exhibited the inferiority of lead coating, for the projectiles deviated from the line of aim considerably more than those of simple iron, and at 10° ranged very unequally and much less; and, as on board ship a gun is never upright for two consecutive seconds, the Armstrong allowances for deflection could not be correctly calculated. The report of firing is annexed (see Tables, pages 28, 29). In practice

also difficulties occur, for the shot cannot be re-fired, and, if the charge be reduced, the accuracy is lessened and air space has to be carefully provided against.

At close quarters, at which decisive actions will ever be fought, the Armstrongs are very inferior in smashing effect, and the many niceties of adjustment necessary to ensure safety will, when men's nerves are highly strained, be certain to result in appalling accidents; for the mere want of tightness is certain to cause a leakage of gas, and to convert portions of the breech apparatus into destructive missiles, at the same time that a suffocating vapour from grease, lead, &c., would fill the deck.

That this is not a highly-coloured picture, is evident from the narrow escapes of the crews in the "Trusty," "Illustrious," "Edgar," and "Marlborough," in which last vessel the cabins and furniture were reduced to a wreck, the gun's crew thrown down, and the captain of the gun scarred on the face; and for this accident there was no apparent cause, but only a suspicion that some grit had stopped the vent-piece from going down properly.

As pivot-guns this ordnance is still more unsuitable, from the numerous delicate parts of the weapon liable in this exposed position to be hit by the grape or case of an enemy; and, if the wedge plan of breech-loading be adopted, the spreading out of two wings or wedges, one on each side of the breech in loading, will increase the chance of the guns being disabled, and the crew hurt by the fragments.

Breech-loaders for Pivot Guns.

It is a mistake to suppose breech-loaders to be well adapted for pivot-guns; the contrary is the case, for, such guns being intended to be fired at great elevations, should be as solid as possible in the breech; the strain upon the rear being very greatly augmented as the elevation is increased. Not only so; but the gun, which has perhaps just got the range, must be brought horizontal before loading, by which a considerable time, and probably accuracy, is lost between the rounds; and, as the muzzle of a deck gun can be easily got at for loading, there seems no reason for opening and weakening the breech, and complicating what can be otherwise better done from the muzzle.

The expense of the Armstrong guns and projectiles is very great, and the fact of their delicacy, and the inability of the guns to fire any but their own carefully prepared shot, might prove a serious disadvantage in war. At Sebastopol, for instance, where we picked up and refired the Russian shot, had our guns been Armstrongs, and the Russians been armed with rifled pieces grooved in accordance with their present plan, they could have easily dovetailed a little lead into the rear of the Armstrongs and refired them; whereas the fine grooves of our guns would have been ruined by re-using their own refired projectiles, and could not have returned a single Russian shot.

Broadside Naval Guns.

Turn we now to ships where the space is confined, and different sizes of shot and different charges have to be provided. What a dilemma poor Jack would be in with two different kinds of ordnance on the lower deck

and three on the upper! Why, in the hurry of action, he would be putting the square shot into the round holes, and the round shot into the square holes. I ask any man who has been on a ship's deck in action to say what does or does not take place. When men are stirred up by the excitement of action they are not able to attend to niceties. I can even speak of the "hurry" which is displayed in the practice on a field-day in the "Excellent," where I have been more than once the sponger or loader of the officers' gun. And what must be the case in a close hand-to-hand fight!

One of the great advantages of rifling, viz. that of enabling a molten-iron shell of very large capacity to be fired in safety, will also be lost. This advantage has been lately overlooked, as the Armstrongs appear unsuited for the purpose; and it cannot, therefore, cause much surprise that, because the loose-fitting round shells of small capacity have produced so little effect from smooth bores, the dangerous hot shot are again talked of as an arm for future use. I trust, however, that they will be given up.

The comparison so often made between round balls and rifled shot, is seldom if ever made as respects their comparative cost and their value at close quarters, but only as respects their effect at distances too great to be correctly measured, or to produce any decisive result in actual warfare. The question, as regards naval ordnance, is not, however, between the round ball and the elongated shell, for the round ball is the most effective, and is far more easily handled and loaded at close quarters, and the rifle shell is the best for bombardment; but between a mode of rifling that *will* admit of the use of the round ball at close quarters, and one that will *not* admit of its use. By adopting the former plan, good broadside guns throughout would be obtained for the decisive struggle,* and this is the first and the main point to secure, and the cost of ammunition would be kept at its old rate; by the latter plan, the broadside power would be lessened, a mixture of different sorts of weapons rendered necessary, and the simplicity essential in naval warfare entirely lost. I need not dwell upon the expense of the ammunition for such finely-grooved guns, nor the doubts about its keeping serviceable in the warm and moist atmosphere of a tropical climate; but I wish to remark, that the guns themselves are so delicate, that the powder cartridges of the 40 and 25-pounders are made up round pasteboard cylinders; and that the fouling, which occasions extra strain on the gun and stripping of the projectile, can only be prevented by the use of a wad composed of various perishable ingredients.

* The 68lb. round ball will perform more work than the Armstrong shot at probably less than a third the strain upon the gun; and a properly rifled wrought-iron piece would send its flat-headed shot with a shell base to burst inside the 4½-inch plates. Such a gun would also fire the round ball, and, when requisite, could use the heavy charges necessary to give a very high velocity in perfect safety. A very high velocity seems to produce an effect far beyond what the formula velocity $^2 \times$ weight gives; and if the generally received rule—that the resistance of armour plates is as the squares of their thickness—be correct, then at 200 yards the actual work done by the 68-pounders is double that of the Armstrong 110-pounders, when both shot are of cast-iron, and fired with 16lbs. and 14lbs. of powder respectively. This result is to be attributed to there not being sufficient time for the particles of iron round the part struck to properly aid in supporting it; and hence, if a much higher velocity can be obtained, and which I think will be the case, we may yet find that strengthened or wrought-iron 68-pounders will send their round balls—but certainly short flat-fronted elongated projectiles—through any target hitherto constructed.—R. A. E. S.

SKETCHES.

Segmental Sections of Comm.r Scotts Centrical Rifling.

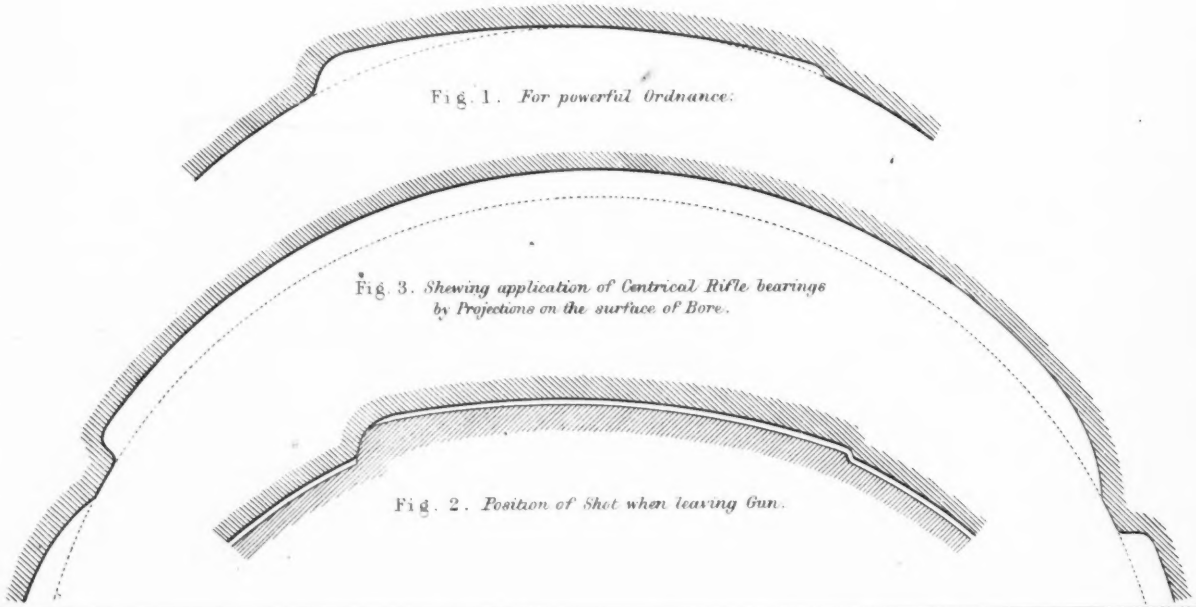


Fig. 1. *For powerful Ordnance.*

Fig. 3. *Shewing application of Centrical Rifle bearings by Projections on the surface of Bore.*

Fig. 2. *Position of Shot when leaving Gun.*

J.R. Jobbins

These difficulties are the result of the fine grooves and the compression system, which, as is well known, is fast destroying the larger Armstrong guns; and although the new 70-pounder is to have a wider groove of altered shape, and a muzzle swell, little advantage will be gained.

Rifling with Plain or with Centrical Grooves.

Were, however, the leaded projectiles and fine grooves to be given up, and any plain groove and a simple iron projectile adopted, these difficulties would be obviated, and a much higher velocity obtained without straining the piece. It is true, that the result might not appear so favourable in target practice, but this could also be met by taking the plan of grooving, which I have already advocated before this Institution, (see Journal, vol. v. p. 437,) and which from its form is very easily sponged, and centres the projectile without jar, while its peculiar curve yields all the accuracy attainable by any known system (Plate III. fig. 1.) Hitherto the plan has not been carried out with great exactness, having been only applied to a cast-iron service 32-pounder gun, to which the projectiles were not fitted with precision; yet, with these disadvantages, and the gun weakened as it was by the rifling (for which it had never been intended), that plan gave an accuracy which was stated to be "good," and a range which at 2° was considerably greater than that of the Armstrong 100-pounder. It has also stood 310 rounds at various *elevations*, although a bad flaw existed in the bore.* The chief peculiarity of the system consists in shoulders for the projectile to glide easily out upon; and as it rests upon three bearings each from 5 to 12 inches long on the long axis of the shot (for shot from 5 to 12 inches in diameter), with a surface-breadth nearly equal to the depth of the rifle grooves (see Plate III. fig. 2), the amount of wear is truly inappreciable. Like the system of De Beaulieu, I confidently expect it will ultimately come to the front; and my only fear is that some inventor, with a longer purse than I have, perceiving the value of my concentric system, may, by some slight modification, gain the ear of those who control these matters and rob me of my labours. It would be easy, for instance, to turn my grooving inside out, and obtain results similar in kind, but in less perfection. You will see that such a figure as this (Plate III. fig. 3) will effect the purpose; but, though Sir W. Armstrong was recently in doubt whether the rib or the groove belonged properly to the bore, I have myself a strong opinion that a rib in such a situation would render even *his* recent composite wad inefficacious, and reduce the gun to the standard of a mere target weapon.

Of such plans we have had enough—they must fail in warfare; for although it is well to be enabled by exact fitting to fire with great accuracy, it is still more important for a weapon not to be rendered useless when this great nicety cannot be observed; or when, as at Sebastopol, on the top of a hill, any kind of shot are most thankfully received. We should, therefore, as suggested in my lecture previously alluded to, while aiming at making really powerful guns, with from 8 to 10 inches or greater

* The muzzle of this gun will be shown in Class 11 in the International Exhibition, together with one of its (seven times) re-fired shells.—R. A. E. S.

diameter of bore—guns which will project their shot with a very high velocity, and consequently flat trajectory, within fighting distances—bear in mind, that heavy charges strain the gun in projecting the rifle shot with a velocity which is readily attained by the round ball; and therefore that the power given by rifling should be added to that of the smooth bore, instead of the latter's being sacrificed to it.

English and French Rifled Guns: their different Nomenclature.

In the facility of using round shot, or adapting almost any sort of shell to its use, consists the value of the French system, and it is also extremely simple and inexpensive; and, even supposing that their guns could not with perfect safety fire more than one or two hundred rounds with elongated projectiles, the French would still have effected a great change at a trifling cost, for they have rifled their 30 and 50-pounders, so as to preserve the round ball and all the old ammunition, and have enabled these guns to discharge, in addition, projectiles, of which that fired from the 50-pounder has a larger diameter than, and probably contains as large a charge as, the Armstrong 100lb. shell.

While, therefore, we have been expending large sums, aiming at obtaining guns which shall be good rifles only, omitting the more important quality of smashing power at close quarters, the French first secured the easily managed round ball, and then added to its effect the advantages of the rifle projectile, in one gun; they have also suppressed varieties of calibres, and in the "Gloire" have carried out this simplification by arming her with 38 rifled 50-pounders; and, unlike our nomenclature, which places the Armstrong 40 above the French 30-pounder, which fires a 60lb. shell, containing more than double the powder charge, they still call their guns by the old names of 30 and 50-pounders: a difference that in the event of hostilities would at least detract from the merit that might otherwise be obtained, were an Englishman armed with the 40-pounder Armstrong to capture an enemy with guns of such very superior power as the French 30-pounders. In fact, with the exception of the 100-pounder, there is no finely-grooved weapon that could produce much effect against even a wooden ship, for the small hole which the shot would make, if they did penetrate, would be a very trifling matter; and the powder charge of the shells of the 40 and 25-pounders is too small to produce any great damage. And thus having endeavoured to indicate the progress of ordnance at home, and to show the value of our rifled guns, I have only to add, that the county owes a debt of gratitude, and something more substantial, to those gentlemen, who, although the service has no claim upon them, have given up years of their time, and incurred much anxiety and expense, in working out a problem so difficult and of such great national importance.

Captain Blakely.—It is rather late to commence a discussion, and I can add but little to the information which Captain Scott has been so kind as to give us on the subject. I would not like the meeting to suppose from what has been said that the French are satisfied with their guns standing only 200 or 300 rounds. On the contrary, they did not cease

their trials until they had fired some of their 32-pounders which had been strengthened, a thousand times, with the full charge of powder and three shot. They then fired one, 3,000 rounds with a single charge of powder and a single shot. So that they are pretty well off. The Spaniards have strengthened their gun—the old 32-pounder. They have tried several different ways of strengthening them. They did not know that there was any law; they did not know the proper difference of diameter to give between the hoops and the cast-iron gun. They had to find this out. They have been very liberal in publishing to the world the exact details of all these experiments, and they had a very good gun to commence with.

They began by making the hoops a little too tight, and the same in every other particular, and they found the gun did not stand so well. They then tried a little larger hoop, until they found out what the exact law was; and the last gun, now used in the Spanish Navy, has been fired 1,367 times with 8lb. of powder and a 62lb. shell. So I think they are furnished with a weapon which at all events is not liable to burst and injure their gunners.

Lieutenant Windus, H.M.I.N., asked whether some trials were not about to take place with the Belgian gun, that had been mentioned, with elongated shot, instead of spherical.

Captain Scott.—Yes; the Belgians have had guns made of Bessemer steel, a metal which they are inclined to adopt. They tested one gun, and it stood an extraordinary number of rounds. There is a clear report upon the subject in Fairbarn's last work on Iron. The leaded shot was taken by ourselves, as well as by other nations, at an early date, because we did not then perfectly understand rifling, and did not know how the iron shot could be shaped so as to truly centre in the bore. The plan of now making a shot cut its passage through the grooves is a great waste of power, especially when you can so easily shape the projectile to the rifling. Fitting is a mechanical operation, in which the English excel. I point this out, because I think we are going in a wrong direction in continuing to manufacture lead-coated shot. They will decay from damp, and those in store are decaying and the lead exfoliating. Many of you are aware that Lord Clyde sent home some bullets which could not be got down into the rifles at all. The lead had exfoliated, and the bullets were too large, and at Delhi several of our men were shot down while trying to force the bullets down the bore of their rifles.

The Chairman proposed the usual vote of thanks to Captain Scott for his valuable paper.

ARMSTRONG BREECH-LOADING 12 PR.

REPORT OF EXPERIMENTAL PRACTICE.

SHOEBURYNESS, 2nd April, 1861.

Height of axis of Gun above plane, 3½ feet.

Ordnance . . { Nature, ARMSTRONG's B. L. 12 pr. Gun, No. 6. Barometer, 29·7.
Wind, South—3.
Weight . . . . . 8 cwt. 2 qrs. 11 lbs.
Length . . . . . 7½ feet.
Diameter of bore . . 3 inches.
Spiral, if rifled, 1 turn in 38 calibres.
Grooves, Number 38. Width, 0·15 inches. Depth, 0·05 inches.

Nature and object of the experiment—To ascertain the Range, &c., of Armstrong's Breech-loading 12 Pr. Iron Gun, in comparison with Whitworth's Breech-loading 12 Pr.

Programme received 28th March. Stores received, 2nd April, 1861. Minute No. 3625.

No. of Rounds.	Charge.	Elevation.	Recoil.	Projectile. Nature.	Projectile. Weight and Mean Weight.	Projectile. Windage in inches.	Times and Mean Time of Flight	Range, 1st graze.	Mean Range, 1st graze.	Deflection. Correction allowed for.	Deflection. Left.	Deflection. Right.	Remarks.
	lbs.	deg.	Feet.		lbs. mean.		sends.	yds.	yds.		yds.	yds.	
1	1·75	2	8·0	Armstrong's Strong Shot.	12	Nil.	3·5	1239	—	Nil.	4½	—	3rd April.
2	—	—	7·10		—	—	3·7	1271	—	—	6½	—	
3	—	—	8·0		—	—	3·6	1238	—	—	6	—	
4	—	—	8·0		—	—	3·7	1307	—	—	4	—	
5	—	—	8·0		—	—	3·6	1226	1256	—	4½	—	
6	1·5	—	7·0		—	—	3·4	1108	—	—	5½	—	
7	—	—	7·0		—	—	3·4	1133	—	—	5	—	
8	—	—	7·0		—	—	3·6	1150	—	—	4½	—	
9	—	—	7·0		—	—	3·4	1121	—	—	3	—	
10	—	—	7·0		—	—	3·3	1137	1130	—	3½	—	
11	1·5	5	6·9		—	—	6·8	2134	—	—	11	—	2nd April.
12	—	—	6·8		—	—	6·9	2165	—	—	9	—	
13	—	—	6·6		—	—	6·6	2157	—	—	8½	—	
14	—	—	6·6		—	—	6·8	2146	—	—	10½	—	
15	—	—	6·6		—	—	6·8	2128	2146	—	7	—	
16	1·75	—	7·9		—	—	7·2	2357	—	—	13	—	Wind increased to 4.
17	—	—	8·0		—	—	7·3	2331	—	—	11½	—	
18	—	—	7·10		—	—	7·2	2356	—	—	11	—	
19	—	—	8·0		—	—	7·4	2351	—	—	11½	—	
20	—	—	8·0		—	—	7·3	2399	2360	—	11	—	
21	1·5	10	4·6		12	—	12·2	3512	—	—	12	—	Wind changed and increased. Squally.
22	—	—	4·8		—	—	12·4	3576	—	—	11	—	
23	—	—	4·6		—	—	—	3593	—	—	17	—	
24	—	—	4·6		—	—	12·4	3597	—	—	12	—	Wind increased to 6, and continued squally.
25	—	—	4·5		—	—	12·2	3563	3568	—	11	—	
26	1·75	—	5·0		—	—	12·8	3943	—	—	8	—	
27	—	—	5·0		—	—	12·8	3898	—	—	23	—	
28	—	—	5·0		—	—	13·0	3961	—	—	14	—	
29	—	—	5·1		—	—	13·0	3866	—	—	19	—	
30	—	—	5.1		—	—	13·0	3873	3908	—	21	—	

Elevation throughout by Quadrant.

The Gun was mounted on a Travelling Carriage, and placed on one of Lieutenant-Colonel Clerk's Platforms, on the level.

Wads, choked in the Cartridge, were used throughout the Practice.

(Signed) A. J. TAYLOR, Colonel R.A.,
Commandant and Superintendent.

The Secretary,
Ordnance Select Committee.

WHITWORTH BREECH-LOADING 12 PR.

No. 1. REPORT OF EXPERIMENTAL PRACTICE.

SHOEBURYNESS, 2nd April, 1861.

Height of axis of Gun above plane, 3½ feet.

Ordnance . . { Nature, WHITWORTH's B. L. 12 Pr. Gun, No. 1. cwt. qrs. lbs. Weight . . . . . 9 3 0 Length . . . . . 8 8/12 feet. Diameter of Bore, Major axis 3 in., Minor 2·75 in. Spiral, if rifled, 1 turn in 55 inches. Grooves, Number . Width, . Depth, .

Barometer, 29·7
Wind, South—3.

Nature and object of the Experiment—To ascertain the range, &c., of Whitworth's Breech-loading 12 Pr. Iron gun, in comparison with Armstrong's Breech-loading 12 Pr.

Programme received 28th March. Stores received 2nd April. Minute No. 3625.

No. of Rounds.	Charge.	Elevation.	Recoil.	Projectile. Nature.	Projectile. Weight and Mean Weight.	Projectile. Windage in inches.	Times and Mean Time of Flight	Range, 1st graze.	Mean Range, 1st graze.	Deflection. Correction allowed for.	Deflection. Left.	Deflection. Right.	Remarks.
	lbs.	deg.	Feet.		lbs. mean.		scnds.	yds.	yds.		yds.	yds.	
1	1·75	2	7·0	Solid Shot—Hexagonal shaped.	12·004	—	3·5	1266	—	Nil.	½	—	3rd April.
2	—	—	7·3		—	—	3·6	1344	—	—	—	3	
3	—	—	7·6		—	—	3·4	1250	—	—	—	2	
4	—	—	7·3		—	—	3·4	1280	—	—	—	1	
5	—	—	7·6		—	—	3·4	1306	1290	—	—	1½	
6	1·5	—	6·6		—	—	3·6	1223	—	—	—	2½	
7	—	—	6·6		—	—	3·6	1211	—	—	—	1½	
8	—	—	6·6		—	—	3·4	1188	—	—	—	2	
9	—	—	6·6		—	—	3·5	1209	—	—	0	0	
10	—	—	6·6		—	—	3·4	1159	1198	—	—	1½	
11	1·5	5	6·0		—	—	7·2	2442	—	—	1½	—	2nd April.
12	—	—	6·0		—	—	6·2	2072	—	—	—	2	
*13	—	—	6·0		—	—	6·8	2389	—	—	—	½	
14	—	—	5·10		—	—	7·2	2449	—	—	—	2	
15	—	—	6·0		—	—	7·2	2486	2368	—	1	—	
16	1·75	—	7·0		—	—	7·0	2475	—	—	2½	—	Wind increased to 4.
17	—	—	7·0		—	—	7·2	2644	—	—	1	—	
18	—	—	6·9		—	—	6·9	2335	—	—	2	—	
19	—	—	7·0		—	—	7·0	2370	—	—	1¼	—	
20	—	—	7·0		—	—	7·2	2533	2471	—	2½	—	
21	1·75	10	6·9		—	—	13·2	4409	—	—	4	—	Wind changed and
22	—	—	6·8		—	—	13·0	4348	—	—	10	—	increased. Squally.
23	—	—	6·8		—	—	12·8	4387	—	—	7⅝	—	
24	—	—	6·9		—	—	13·0	4405	—	—	8⅝	—	Wind increased to 6, and
*25	—	—	6·9		—	—	13·4	4449	4400	—	4	—	continued squally.
26	1·5	—	5·0		—	—	12·6	4137	—	—	4	—	
27	—	—	5·6		—	—	12·9	4299	—	—	3	—	
28	—	—	5·0		—	—	1·0	4139	—	—	2½	—	
29	—	—	5·0		—	—	12·8	4318	—	—	3⅜	—	
30	—	—	5·0		—	—	12·8	4220	4223	—	2	—	

Elevation throughout by Quadrant.

The Gun was mounted on a Travelling Carriage, and placed on one of Lieutenant-Colonel Clerk's Platforms, on the level.

The Powder and Wad were contained in the usual Tin Cases.

The rounds marked * were fired with Tin Cases that had been used previously, there being no more in store, and they were simply well cleaned, and answered quite as well as when new.

The Wad weighs about 2 oz. 4 drs., and the empty Tin Case about 8 oz. 8 drs.

(Signed) A. J. TAYLOR, Colonel R.A.,
Commandant and Superintendent.

The Secretary,
Ordnance Select Committee.

Official Reports, as extracted from the excerpt Minutes of Proceedings of the Institution of Civil Engineers.—ED.

Friday, January 17th, 1862.

CAPTAIN SIR F. E. NICOLSON, R.N. C.B. in the Chair.

LIFEBOATS.

BY CAPTAIN J. R. WARD, R.N.

I.—*Preliminary Remarks.*

IN a country bounded on all sides by the sea, whose earliest associations are connected with it, through the medium of which it has derived its civilisation, its wealth, its grand political status, and probably to a great extent the energy, enterprise, and indomitable spirit of its inhabitants;—in a country whose almost innumerable ships ceaselessly traverse every sea, and are harboured in well nigh every port on the globe we inhabit;—and, above all, in a country whose shores in every winter's storm are strewn with the wrecks of its ships and the corpses of its sailors;—in such a country it may well be presumed that an instrument devised to save the helpless castaway from an untimely end will be an object of general interest.

Such an instrument is a lifeboat! I feel therefore under no other embarrassment in offering some explanations on its character and specialities than that which arises from the fear lest I should not do justice to so important a subject.

As it is a subject not very generally understood, it will be necessary to go into some details that will be familiar to many present, whose indulgence I have therefore to ask.

I propose, successively, to explain the general principles on which lifeboats are constructed as compared with other boats; the peculiar properties of the principal descriptions of lifeboats now in use on the coasts of the United Kingdom; the character of their equipment; and the system under which they are provided and managed in this country, especially those belonging to that noble institution to which I have the privilege and happiness to be attached—the National Lifeboat Institution.

II.—*Distinctions between Ordinary Boats and Lifeboats.—Properties of Lifeboats: Extra buoyancy, self-discharge of water, stability, self-righting, internal capacity, speed, weight, strength of build, material, &c.*

Although the word lifeboat has not in itself any definite meaning, it is pretty generally understood as signifying a boat especially constructed for saving lives in storms and heavy seas; when ordinary open boats could not attempt to do so, except at the imminent peril or certain destruction of those within them.

What then are the causes which make ordinary open boats unsafe in rough seas? And in what manner are those causes removed in lifeboats?

The principal causes of a common open boat being unsafe in a heavy broken sea are its liability to fill with water and swamp from a wave breaking into it, or by its upsetting, and loss of stability from all water within it falling to one side with every motion of the boat. It is therefore obvious that the chief requirement of a lifeboat is the counteraction, as far as possible, of these defects.

Extra Buoyancy.—The first essential property then in a lifeboat is what is termed extra buoyancy; which property is in a greater or less degree common to all lifeboats, excepting to some of the so-called lifeboats, which, to meet the requirement of a loosely-worded clause in an Act of Parliament, are placed on the decks or hoisted up to the sides of many of our merchant vessels.

Extra buoyancy may intelligibly be defined as the excess of floating property in any body immersed in a fluid, the expression of which in pounds indicates the number of pounds weight of any other body that it is capable of floating in addition to itself. Thus a log of fir timber, the specific gravity of which wood is about half that of water, will float with only half its body immersed, the remaining half representing its extra buoyancy. A piece of dry fir wood has therefore extra buoyancy about equivalent to its own weight.

This important property in a lifeboat should be sufficient in amount to enable it to be loaded with people, and nearly filled with water, without its then being so deeply immersed as to be unmanageable.

Extra buoyancy in all our coast lifeboats is now chiefly obtained by occupying a sufficient portion of the interior with enclosed water-tight compartments or boxes. These compartments by being placed along the sides of a boat, and at its extreme ends, are made to serve the further purpose of adding to stability, by confining all water that may be shipped to the central part of the boat, where it is in some boats made to perform the office of ballast.

The mode in which this property is applied to the different descriptions of lifeboats will be best explained by diagrams and models.

In Plate I. representing transverse sections of the five principal descriptions of lifeboats in use in this country, the air-tight compartments which form the extra buoyancy are marked A.

It will be observed that in figures 1, 2, and 3, this extra buoyancy occupies a large portion of the interior of the several boats, so that if filled with water they would evidently still float buoyantly; whilst fig. 4 represents a section of a tubular boat, which, having no interior corresponding with that of an ordinary shaped boat, can contain no water. Fig. 5 is a section of one of Whyte's ship's lifeboats. It has not so much extra buoyancy as figures 1, 2, and 3, but has sufficient for an ordinary ship's lifeboat.

By the proper application of this principle, we have then not only an insubmergible boat, but the possession of other valuable properties, which are so mingled with it as to make it difficult to separate the one from the other. Thus, as in figures 1, 2, 3, and 5, by occupying the interior space along the sides of a boat with air-tight compartments, the water within her is, in varying degrees, prevented from falling over to the lower side; and lateral stability in a rough sea is thereby much increased. Again, as shown in figures 1 and 3, by placing the greater part of the extra buoyancy beneath a water-tight deck, means are provided for self-discharge of all water falling into the boat above the deck, through the instrumentality of connecting tubes between that part and the open sea below.

And again, as in fig. 2, by attaching large buoyant wales, or fenders, or pads, as they are variously termed, round the exterior sides of a boat, both lateral buoyancy and resistance to sudden heeling over, and thereby lateral stability, are increased.

Lastly, by occupying the extremities at bow and stern with enclosed air-compartments, the properties of self-righting and longitudinal stability are provided.

Self-discharge of Water.—Since however, notwithstanding great extra buoyancy, it would be inconvenient and unsafe for so large a quantity of water to remain in a boat as often falls into one from a single broken sea or surf, another requisite property is at once apparent, viz. that of self-discharge or self-relief of water. Indeed, without this property, the full advantage of that of extra buoyancy is not realised, as without it all water breaking into a boat must remain in her, and become a shifting cargo, settling more or less on one side or at one end with her every motion.

Having then already the property of extra buoyancy, nothing more is needed, in order to effect the self-discharge of all water above the level of the outside sea, than to have a sufficient number of open holes in the bottom of the boat. Through such openings all water shipped from above must then pass out by its own gravitation, until lowered to the outside level.

In some descriptions of lifeboats, as in figs. 1 and 3, self-relief of water is total, unless they are very heavily laden with passengers or other weights; in others, as in fig. 2, it is only partial, a large quantity of water below the outside level remaining in the central part of the boat, where it serves as ballast.

In figures 1 and 3, the watertight deck before alluded to, which is there shown by the line B, forms the inside floor of the boat; it is laid with considerable sheer, *i.e.* curved upwards at bow and stern, so that all water over it should settle to its central part. Between this central part of the

Fig. 1.

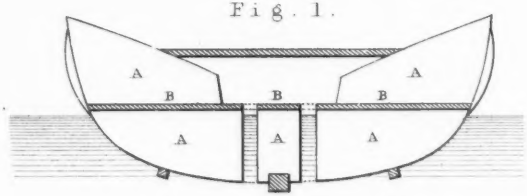


Fig. 2.

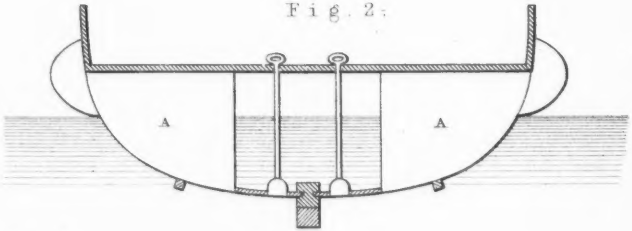


Fig. 3.

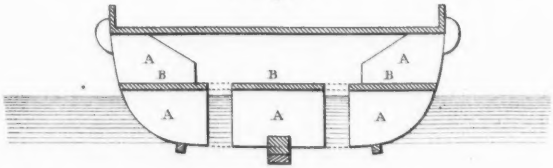


Fig. 4.

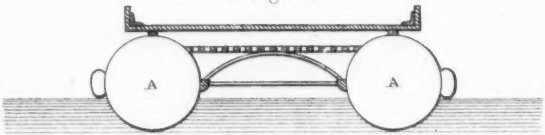
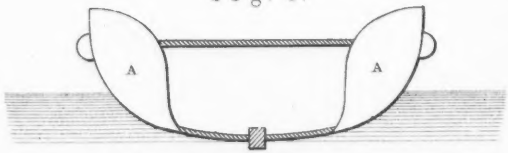


Fig. 5.



J.R.Jobbins.

deck and the floor of the boat below, passing through the intermediate space, tubes of metal are fixed, varying in size and number in different boats, and open at both ends; thus opening passages between the space above the deck and the sea below the boat, but excluding all communication with the space between the deck and the floor—just as a chimney open at both ends passes from a groundfloor to the exterior of a building above the roof through intermediate apartments, whilst excluding communication with them.

These tubes vary in size, from 3 to 6 inches in diameter. The smaller they are, the more are required. As a single wave breaking into a boat will often fill her to the thwarts, there should be a sufficient number of relieving tubes to clear her of that quantity in twenty or thirty seconds. These relieving tubes in all the old classes of boats, as above stated, are open at both ends, and therefore freely admit the ingress of water from below, as of its egress through them from above. To remedy this defect, which is not an unimportant one in some boats, an ingenious self-acting valve has been invented, which valves are fitted in all the lifeboats on the plan of the National Lifeboat Institution. It is a simple plate, fitting the tube at its upper end, and made to turn on an axis on one side of its centre, as does an eccentric wheel. It is so balanced as of itself to remain shut, and on the slightest pressure of water from below, to shut still closer, whilst, on water falling on it from above, the pressure on the larger division of the plate, being necessarily greater than on the smaller, opens it downwards. Valves, unless self-acting, and of very simple construction, are objectionable; but these are found to answer admirably, and some which have been ten years in use are still efficient, and have never got out of order.

In the Norfolk and Suffolk water-ballasted lifeboats, fig. 2, Plates I. and II. which have no decks, there are merely holes in the floor, with large plugs to them. There are two of these holes, with corresponding plugs, at every thwart. The plugs have long handles, similar to those of common spades, so that the men sitting on the thwarts can insert or withdraw them at pleasure. Being large powerful sailing boats, and very heavy, it is a great convenience to be able to handle them on the shore without the weight of the larger portion of their ballast. They are therefore launched empty; but as soon as they are clear of the beech, and before entering the heavier part of the surf, the plugs are withdrawn, and the water admitted until it rises to the outside level. The water thus let in varies in amount from four to seven tons in different boats. Through the open holes the water within, after a sea being shipped, will always subside to the level of the outside water, all below that level remaining as a constant quantity. In some lifeboats, as in fig. 5, and in all other ships' lifeboats now in use, no provision is made for the relief of water except by baling. It must be acknowledged that all such boats are without one of the most requisite qualities of a good lifeboat.

In the tubular lifeboat (fig. 4) it will be seen that this property is attained in the greatest perfection, as, having no open interior, no water can lodge within her.

Stability.—The next quality of essential importance is lateral stability, or resistance to upsetting sideways. Stability may be obtained by three modes: 1st. By great breadth of beam; 2nd. By occupying the interior

with air cases, as described already, in such a manner as to leave no space for water to remain in the interior, into whatever position the boat may be thrown, or to so confine it to her central part that it cannot fall much to one side above the centre of buoyancy; 3rd. By ballast. There is a limit to the application of each of these modes, which requires careful consideration. 1st. Great breadth of beam, in proportion to length, is a certain mode of securing great stability, but it adds to weight, above the centre of buoyancy, and by increasing the area of the "midship section" entails loss of speed, requiring proportionally greater propelling power. It also prevents the application of another important property—that of self-righting, in the event of being upset.

The widest rowing lifeboats are those of the North Country, or Greathead plan (fig. 1, Plate I.), some of which have 10½ and 11 feet beam to 30 feet length. The Norfolk and Suffolk boats (fig. 2) have also great beam, the largest having 12 feet to 46 feet length; they are, however, exclusively sailing boats.

In sailing boats, increase of beam can be very well given, as greater power of propulsion can be obtained by enlarged sails; but in rowing-boats this power can only be had by using longer oars, with two men to each, which thereby incurs the risk of an unnecessary number of lives. In one of such boats twenty-two men out of a crew of twenty-four perished at Shields by her being upset in the year 1850.

2nd. A most valuable means of adding to the stability of a lifeboat, as intimated under the last heading, is by occupying its sides with buoyant cases. By an examination of Plate II. the relative properties of different lifeboats in this respect will be readily perceived. It will be noticed that the North Country lifeboat (fig. 1) is possessed of this property to the fullest extent; as, if thrown over with one gunwale to the water's edge, there will only be space for a very small quantity of water to lie in her at the level of the outside sea, and that little but slightly on one side of the centre of gravity.

The continuation of the side air-cases to the gunwales, as in those boats, is, however, in another respect detrimental, by occupying space which is valuable for the stowage of wrecked persons.

In fig. 2 a greater quantity of water is retained, but the larger portion of it is on the windward or higher side of the centre of buoyancy, where it serves the purpose of ballast, and thereby adds to the stability of the boat.

In fig. 3 there is space for a larger quantity of water, some sacrifice of this important quality being made, to enable the scarcely less valuable property of self-righting to be brought into play, which great side buoyancy, placed high, would prevent.

In fig. 4 it is evident that no water can remain in any position.

In fig. 5 a large quantity of water might lie on one side of the centre of buoyancy, but the loss of stability arising therefrom is counteracted by large side buoyancy, placed high.

Ballast.—There remains the third principle of stability, ballast. Ballast may be either solid or liquid. Solid ballast is most frequently applied, in the shape of an iron keel, in which position, at the lowest part of a boat, it acts with the most powerful leverage. Iron keels in lifeboats vary from

3 to 17 cwt. Ballast formed of wood, and of cork enclosed in water-tight cases, is also used in the self-righting lifeboats of the National Lifeboat Institution, of nearly equal weight to the iron keel. Thus a 10-oared boat 32 feet long has an iron keel of 9 cwt. and nearly the same weight of wood, or of cases of cork stowed beneath the deck.

It is difficult to some persons to imagine that wood or cork can partake of the nature of ballast. In fact, however, any substance heavier than air may be used as ballast, a pound of cork being as much ballast as a pound of iron or lead. The advantage of employing a ballast of less specific gravity than water is that, in the event of a boat being stove in and the spaces below the deck filling with water, the extra-buoyancy of the material then comes into play, and prevents the boat from becoming so deeply immersed as to become unmanageable.

In February, 1858, the National Lifeboat Institution's lifeboat at Youghal, in Co. Cork, in launching got stove on a rock and a hole was made in her floor as large as a man's head; she became at once much more deeply immersed, and the water rose to 5 or 6 inches above her deck, the spaces beneath it having filled with water. Nevertheless she proceeded on her mission of mercy, her gallant crew rowed her two miles to a wrecked Austrian ship, and in the midst of a very high surf, which frequently broke over and filled her, she took fourteen men from off the vessel's bowsprit and conveyed them safely to the land. Had all her ballast been of metal she would, undoubtedly, have become so deeply immersed after being stove that she could not have proceeded to the wreck, and all those poor men would have perished.

As, however, a large quantity of fixed ballast causes great extra labour and difficulty in land transport and launching, water ballast is occasionally employed. It is sometimes enclosed in water-tight tanks, but more frequently, as in the Norfolk and Suffolk boats, is unconfined.

In consequence of the liability of enclosed tanks to leak from decay or injury, and of the water thereby spreading over the whole floor of the boat, water ballast has been discontinued in most rowing lifeboats. I am however of opinion that, if properly applied and secured, it would be free from any risk, and might often be employed with much advantage.

With the exception of three or four of the old boats on the North Country plan, which still retain water tanks, the only boats in the United Kingdom now ballasted with water are the Norfolk and Suffolk boats, fig. 2, already alluded to.

These latter boats deserve especial notice. They are only eleven in number, nine of them being exclusively sailing boats varying from 39 to 46 feet in length, and from 10½ to 12 feet in breadth.

As they are unmanageable in a heavy sea under oars, and as they have often to work to windward against the heaviest gales to the rescue of the crews of vessels wrecked on the numerous outlying banks which exist off that part of the coast, it is indispensable that they should be heavily ballasted, and have considerable draught of water, to give them good weatherly qualities. In order, then, to make this requisite provision, without involving too much weight for convenient launching, they are provided with water ballast, in addition to having iron keels. This water is let in by the same apertures that serve for self-relief of water, the plugs

which close them not being withdrawn until the boat has got off the beach. The water thus let in is of very large amount, being in the largest boat of this class not less than seven tons—which water is not retained in an enclosed tank, but left to fill up every unoccupied space up to the level of the plane of flotation. By the representation of a cross-section of one of these boats in fig. 3, Plate I., it will be seen that this unoccupied space is chiefly confined to a narrow channel of about one-third of the boat's width. Cross air-cases at bow and stern, to the level of the thwarts, also confine it lengthwise. The average area of these channels is about 20 feet long by 4 feet wide, in which the water lies to an average depth of $2\frac{1}{2}$ feet, in amount equal to about 200 cubic feet, or $5\frac{3}{4}$ tons.

A large quantity of water also settles between the large timbers of these boats, beneath the side and end air-cases, which cases are moveable separate boxes, and cannot be made to fit so closely as to fill up these spaces. These boats have also iron keels varying from 12 to 17 cwt.

At first thought it would appear highly dangerous to have so large a quantity of water loose within a boat; the truth is, however, that the safety of the principle consists in the largeness of the quantity, taken together with the circumstance of its being cut off from access to the ends and sides of the boat. If these boats were less heavily ballasted, they would be more lively, rising and falling with every motion of the sea, and the water within them would be constantly in motion towards the lowest level; but thus heavily weighted, and propelled by powerful sails, they cut deeply through every sea instead of rising to it—they, in nautical phraseology, make much worse weather of it than a lighter and more lively boat would do; heavy bodies of "green sea" break over them so as sometimes to altogether submerge their crews, and to hurl them from one end of the boat to the other; but their stability is so great that their crews have unbounded confidence in them, and they are protected against being washed overboard by "ridge ropes" rove through iron staunchions round the boat, fixed in the gunwales.

The only boat of this class which has ever upset was the Southwold lifeboat in February, 1858, the then most recently constructed boat of the class. She was taken out, through a rather high surf, for the quarterly exercise of her crew. On returning to shore, before entering the surf, the crew injudiciously inserted the plugs and pumped out about two-thirds of the water ballast. They then ran her under sail, with too much way, into the surf, when, a sea overtaking her, threw her stern up; the ton-and-a-half of water still in her then rushed to the bow, which became completely submerged, and, broaching to across the surf, she immediately upset; her masts broke off on coming in contact with the ground, and not being a self-righting boat she remained keel up. Her crew of 15 men all having on their life-belts, in accordance with the rules of the National Lifeboat Institution, were saved; but three gentlemen who had gone off as amateurs, and had refused to put on life-belts which had been offered to them, were drowned, although one at least of them was known to be a good swimmer. Had this boat been full ballasted, the sea would probably have broken over the stern instead of lifting it, and the accident would not then have occurred.

In this lifeboat, in consequence of the crew having withdrawn their

confidence from her after the accident, and as they also thought she floated too deeply in the water, the water-ballast channel was at my suggestion filled in with portable solid blocks of fir timber up to the level of the former water-ballast, she being thus provided with fixed ballast of half the weight of the former water. Since that alteration she has given every satisfaction to her crew. I have thought this circumstance deserving of mention, since the question as to the relative merits of water and solid ballast will, I have no doubt, continue to be a disputed one.

Although, however, this principle of ballasting with a large quantity of unconfined water has on the whole answered well in the large sailing boats above referred to, I consider it to be inapplicable to rowing boats, which, being of smaller size, and only slowly propelled against high surfs, would be liable to be thrown so much out of a horizontal position as to cause the water to settle at one end, as in the Southwold boat, and thereby endanger upsetting. I feel sure that I have many times been through heavy surfs in the self-righting rowing lifeboats of the National Lifeboat Institution, which would have proved fatal to any rowing boat so ballasted. It is also a serious drawback to such boats that their crews, whilst rowing, must sit with their feet in the water, which, in a protracted service in cold weather, cannot but be very trying to them.

Self-righting.—I come now to the explanation of a property which, by comparison, is a novel one, although more than two-thirds of the lifeboats in the United Kingdom are now provided with it,—a property the value of which has been disputed by many, and for the adoption of which in its lifeboats the National Lifeboat Institution has been accused by some of pursuing a phantom. I allude to the property of self-righting, by which the self-return of a boat to its normal position, after being upset, is effected.

Previous to the year 1852 no self-righting lifeboat existed, although the power to make a boat self-right was ascertained by experiment, and recommended for use by the Rev. James Bremner, in the year 1792.

That which led to its first practical application was the offer, by his Grace the Duke of Northumberland, of a prize of 100*l.* for the best model of a lifeboat, in the year 1850, consequent on the upsetting of one of the Shields lifeboats, and the drowning of twenty-two out of twenty-four men, who formed her crew, to which I have already alluded.

In a statement addressed on that occasion to the boatbuilders of the United Kingdom, by a committee nominated by his Grace, the different qualities to which a certain value would be attach d were named, and amongst them was included that of self-righting, which property was possessed by the boat to which the prize was subsequently awarded.

I shall, under another heading, have more particularly to refer to the circumstances attending, and the results following, the Duke of Northumberland's philanthropic offer, so will not now break the thread of a progressive definition of the properties of existing lifeboats. A most mistaken notion has not uncommonly prevailed amongst those who have not studied the subject, that the property of self-righting was merely a strong tendency to revolve in the water, just as a floating cask if set in motion on its axis will complete several entire revolutions round the same before it will stop, and that therefore in the same ratio that a boat is made to

possess the property of self-righting must she also have a tendency to upset. This hypothesis is no "Frankenstein" of my own, but one which I have had several times to disprove with a serious countenance.

I think I shall be able to make it clear that the real difference between an ordinary and a self-righting boat is, that whilst the former, on being thrown by a sea or other force on one side beyond a certain angle, offers no further resistance, and cannot return; the latter, on the contrary, continues to oppose such a force in every position in which it can be placed, unless nicely balanced with its keel exactly above the centres of gravity and motion, or, in nautical *parlance*, "keel up," a position in which it could not even momentarily remain in a rough sea.

The only familiar object that occurs to me which will serve as an illustration of the principle, is one of those children's toys called "tumblers," which, into whatever position you may force or throw it, will most obstinately self-right, and certainly show no disposition to revolve on its centre, or even to make a second "somersault" without a second application of physical force. This quality of the child's toy is precisely the same as that in operation in the self-righting lifeboat.

To obtain this peculiar property in a boat, all that is required is to attach to her a heavy iron keel, or otherwise ballast her heavily; to give her a fair sheer of gunwale; and to enclose a portion of her bow and stern as watertight air-chambers, as shown in the models on the table. The amount of ballast and the size of the air-chambers are of course matters for careful calculation.

The manner in which the desired effect is produced will be at once perceived on examination of the drawing or model of one of these boats. The bow and stern air-chambers having sufficient buoyancy to support the whole weight of the boat when keel up, she is then floating unsteadily on two points, with the heavy iron keel or other ballast carried in an elevated position above the centre of buoyancy, thus forming, in mechanical language, an unstable equilibrium, in which dilemma the boat cannot remain—the raised weight falls to the one side or the other of the centre of gravity and drags the boat round to her ordinary position, when the water shipped during the evolution quickly escapes through the relieving tubes, and, those of her crew who have been thrown out of her regaining her, she is again ready for any service that may be required of her.

The National Lifeboat Institution was, at an early period, warned by opponents to the system, that the self-righting of a boat would prove useless, inasmuch as that it would rarely happen that those upset from her could regain her or again get into her. Facts have since proved the invalidity of these prognostications, as these boats have upset and their crews *have* regained them and again got into them, whilst the crews of other lifeboats which have upset have perished.

Notwithstanding this manifest advantage, it might still be questionable if any other important principle should be sacrificed to effect it. But, if it can be shown that it can be introduced without any such sacrifice, it would surely be reprehensible in those who employ others on so dangerous a service as the rescue of shipwrecked persons, not to provide them with this additional means of safety.

Without blinking the question I will at once point out how far any sacrifice has been made to secure the self-righting property.

Its requirements are :—

1. Ballast.
2. Enclosed air-chambers at bow and stern placed sufficiently above the centre of gravity.
3. Limited breadth of beam.
4. Limited side buoyancy.

1. *Ballast.*—Now the first of these requirements, ballast, is a positive source of safety. It necessarily increases lateral stability, and by adding to the weight of a boat gives a greater momentum when rowing against a high broken sea; which is often a source of safety, as she may thereby pass safely through or over a sea, instead of being driven astern by it. From the same cause also, she can be more readily held back, and be prevented from "running" on a sea when returning to the shore, which is one of the greatest dangers that a boat can encounter.

2. *Raised Air-Chambers.*—The second requirement, raised air buoyancy at bow and stern, is a great source of safety, by preventing all water or other weights from settling at either extreme end of a boat, and also by preventing much water from breaking over the bow or stern.

It will be readily conceived how advantageous it must be, on a heavy sea breaking over the bow of a boat, to have a buoyant power equivalent to more than a ton weight instantly resisting submersion. I have myself been too many times in the bows of the boats of the National Lifeboat Institution, in heavy surfs, not to have learned to appreciate the advantage. I believe also, from my personal observation of them, that, placed under the same circumstances, one of the North Country lifeboats would take half-a-ton of water into the bow from a single surf, where a good self-righting boat would scarcely ship a bucket-full.

3. *Limited Beam.*—I admit that great breadth of beam is a source of safety, as giving increased stability, and that some sacrifice of beam is required for self-righting. But great breadth of beam involves loss of propulsion against a heavy sea, which is often loss of safety, and requires the use of longer oars with more men to work them, all which are disadvantages. A self-righting boat with limited beam (say one-fourth of length) has, therefore, the advantage over the wider boat in these respects, whilst the loss of stability from diminished beam is made up for by an equivalent stability derived from ballast.

4. *Limited Side-buoyancy.*—I grant that some sacrifice of stability is made by a reduction of side-buoyancy, but it is the only real sacrifice, and is, I think, more than made up for by the gain of the self-righting power.

A further comparison of the relative advantages of righting and non-righting boats will come more regularly under a special heading devoted to a review of the existing lifeboats in the United Kingdom.

Internal Capacity.—Another quality in a lifeboat on which some stress has been laid is, what is termed "internal capacity," *i.e.* the amount of unoccupied space within a boat which might be filled with water on the breaking into her of a sea. The amount of "internal capacity" is determined by that of another property already considered. Given a certain amount of "extra buoyancy," and the remaining space still unenclosed

constitutes what is usually implied by internal capacity. Practically, however, internal capacity is only that amount of space in which water will remain in a boat when lying on one side, with one gunwale only awash; for, if a boat should be absolutely filled to the level of the gunwales by a surf (a thing which I have never seen myself, and which I suspect is of very rare occurrence, unless in one of the deep, water-laden Norfolk lifeboats), the first motion of the sea would throw the greatest portion of it over one side; the small quantity that would then remain in her, and of which her discharging tubes would not relieve her, as shown in figures 1, 2, and 3 (Plate II.), is then in reality an index of her internal capacity.

Speed and Weight.—After the properties already explained, and which may be more especially termed the safety properties of a lifeboat, the next in importance is speed; for there would manifestly be no utility in providing the safest contrivance for taking off the crew of a wrecked vessel if it could not be propelled to her in time to be of service. Frequently indeed, as stated in a former paragraph, speed constitutes safety, as the slow boat may be carried back by a heavy sea, and up-ended, or turned athwart, when the faster boat would have quickly passed through and over the danger. To obtain speed, or frequently any progressive motion, against a heavy sea—I speak of rowing-boats—fine lines and especially sharpness of bow are necessary, as in an ordinary boat, and that not at the waterline only, but carried up quite to the stem-head, which is immersed by every heavy surf which it meets. So also lightness, which is an advantage in smooth water, is an obstacle against a head-surf, when the momentum of greater weight without increased bulk is required to carry the boat through the moments of sudden resistance from the successive blows of heavy seas; just as the momentum of the familiar "flywheel" is required in many common machines to continue and equalise motion, as in turning a wheel by a crank. The greater the length of a boat in proportion to area of midship section, weight being the same, the greater will be her momentum, and the faster will she be propelled against a head sea. The proportion of four feet of length to one foot of width of midship section is that which is now being adopted by the National Lifeboat Institution in its double-banked rowing-boats. In its single-banked boats, which are stationed at places where larger and heavier boats could not be managed, still less proportional width is given.

The preceding are all the important properties that have to be considered in a lifeboat, although there are certain other conditions that follow as a matter of course; such, for instance, as sufficient roominess for stowage of a considerable number of wrecked persons, and for the rowers to use their oars with advantage; and great strength of build, to be qualified to stand the violent shocks which such boats must sometimes sustain from collision with wrecked vessels or contact with the shore.

In connection with this last-named condition, I may here state that most of the old classes of lifeboats are clinker or clench built, of oak wood. The self-righting boats of the Institution are built of fir, on the diagonal principle, which mode of build affords great strength and elasticity. The tubular boat of Mr. Richardson is made of tinned iron.

Having explained the especial properties required to be possessed by

Fig. 1.

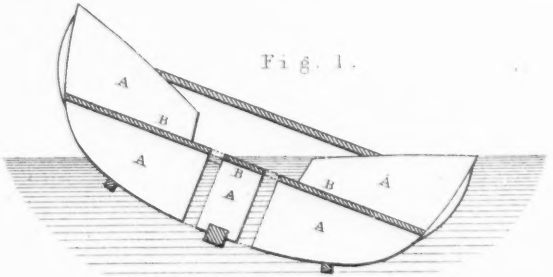


Fig. 2.

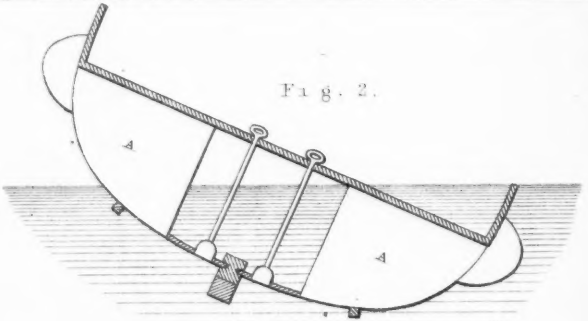


Fig. 3.

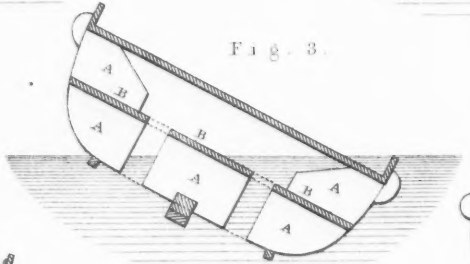


Fig. 4.

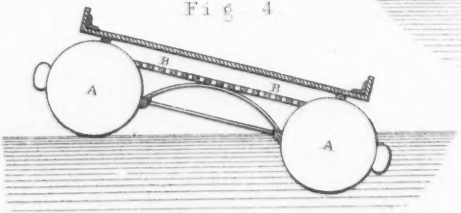
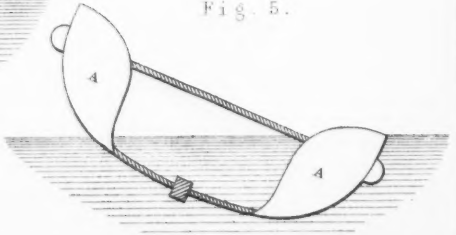


Fig. 5.



J.R.Jobbins

lifeboats, I will briefly state the peculiarities of the principal existing boats, and the history of each, and offer an opinion on their relative merits so far as I have had opportunity for judging of the same. I may first, however, observe, that one of the great obstacles to improvement in lifeboats has been, that opportunities have not existed for comparing, one with another, their several qualities. Each boat has been known in its own locality by its own crew, who have been unacquainted with any other. However indifferent as compared with others might be her qualities, if she has been fortunate and met with no accident, she will in general have won the entire confidence of the local boatmen, who will think there is no other boat equal to her.

So also the builders and designers of lifeboats have had no opportunity to test their own by comparison with others: such experiments are too costly to be attempted by individuals, for, independently of the great cost of a good lifeboat (rarely less than 200*l.*) the expense of its removal from place to place to be brought into contact with other boats, and of its care whilst waiting favourable opportunities of trial, would be considerable; whilst the great cost of making such trials, which the local boatmen would never undertake, for any private persons, in a sufficiently rough sea to be of value, without very large remuneration, would alone be sufficient to deter most persons from incurring the same; especially as the whole might be thrown away if the boat should after all turn out worthless. Again! supposing such a boat were to upset and drown several of her crew when out for trial, who would undertake the support of their widows and orphans?

I have alluded to these difficulties to shew how few persons can be qualified to give a practical opinion on the relative merits of lifeboats, although it is not uncommon to hear inventors or partizans of particular descriptions of boats pronounce dogmatically as to their superiority to all others.

Having now held the office of Inspector of Lifeboats to the National Lifeboat Institution 10 years, and on my periodical rounds on the coasts of the United Kingdom having not only had opportunities for examining and learning the "local character" of every lifeboat in the kingdom, but also for going afloat several hundred times in lifeboats, and often in the heaviest surfs, I have necessarily some experience of them. I could nevertheless wish that it were greater, especially as regards the older classes of boats, which, being less numerous than the newer self-righting boats, and mostly not belonging to the Institution, I have had fewer opportunities for testing in heavy surfs—I give my opinion, however, for as much as it is worth.

III.—*Review of existing Lifeboats.*

1. *North Country Lifeboat. Plate I. fig.* 1.—This Lifeboat is commonly called the "Greathead" boat, as a Mr. Henry Greathead, boat-builder, of South Shields, who built the first boat of the class, in the year 1789, was the reputed inventor of it. Since, however, a Mr. William Wouldhave always asserted that he was really the original designer of it, although he had not the means of building a boat from his design, I have preferred

calling it the North Country Boat—a considerable number of boats, all more or less derived from it, having been placed on the east coast of Scotland, and of England north of the Humber. There are now eighteen of this class of boats on the coasts of the United Kingdom. They mostly belong to harbour and dock corporations, and to local lifeboat associations at trading ports on our north-eastern coast, Shields, Sunderland, and Hartlepool being the chief. The oldest lifeboat now existing is of this class. She was built in 1802. She is stationed at Redcar in Yorkshire, and is now the property of the National Lifeboat Institution. As no accident has ever happened to her, the Redcar boatmen have unbounded confidence in her, and would not exchange her for any other boat that could be given to them.

These boats have undoubted advantages: their great breadth and the exclusion of all water from their sides give them much stability, and their great curvature of floor and keel enables them to be turned more quickly to meet a sea, and to run more safely before a surf than a straight keeled sharp-bowed boat can do. These peculiarities of form are, however, unfavourable to speed, and cause them to steer wildly.

This is the earliest description of lifeboat of which we have knowledge. The largest of the class is rowed by 12, the smallest by 8 oars, double banked. They are neither provided with sails or rudders, being exclusively rowing boats, their great curvature of keel *(vide models)* unfitting them for sailing, and the boatmen preferring to steer them with two long oars at the stern, by the use of which they can turn a boat much more quickly to meet a sea than with a rudder, especially when she has but little way on her, which must always be the case when rowing against a heavy sea and gale. Notwithstanding their great stability, several of these boats have upset from time to time, occasioning the loss of many lives. They cannot be made to self-right after upsetting, and they ship much more sea than do the self-righting boats. On the whole I much prefer the latter to them.

2. *The Norfolk and Suffolk Sailing Lifeboats.* *Fig.* 2.—Of the lifeboats now in use, those next in antiquity are the Norfolk and Suffolk sailing lifeboats. The oldest of which we have any knowledge was one recently condemned at Great Yarmouth, which was built in 1833.

These are splendid boats for the especial use for which they are required—viz., as sailing boats to proceed to wrecks ashore on outlying banks, and not being required for closer service, which would need to be performed under oars. As exclusively sailing boats, I believe them to be unequalled. Yet, from various causes, there is perhaps scarcely any other part of the coast for which they would be useful, unless on Deal beach, for service on the Goodwin Sands.

I have never myself had an opportunity for going out in one of these boats in a very high sea ; but the services performed by the crews of some of them have been noble, especially by those at Lowestoft and Pakefield, in Suffolk, and at Caistor, in Norfolk. As rowing lifeboats, I have, under another heading, stated that I think them unsuitable.

3. *The Self-righting Lifeboats of the National Lifeboat Institution.*—Previous to the year 1852 all the lifeboats in the United Kingdom were modifications of one or the other of the two classes of boats just described,

excepting four or five on a plan, now obsolete, invented by Mr. Plenty, a coachbuilder in Berkshire, and the Liverpool lifeboats. These latter were simply fine powerful boats, having a large portion of their interior occupied with empty casks as extra buoyancy, but not provided with any means for self-discharge of water.

Under the head of *Self-righting* I have already stated that in the year 1850 His Grace the Duke of Northumberland offered a prize of 100*l.* for the best model of a lifeboat. In response to that offer no less than 280 models and plans of lifeboats were submitted. They were deposited at Somerset House, where they went through a long series of examinations and tests by a committee, ably presided over by Captain Washington, R.N., and of which James Peake, Esq., the present master shipwright of Devonport Dockyard, was a member. The task that this committee had to perform was a most onerous and difficult one. Here were before them a very large number of plans, the selection from which was a matter, it might be, involving the life or death of many hundreds, perhaps even, looking to the future results of their decision, of thousands of individuals. Yet I believe that no member of the committee had ever been afloat in a lifeboat in a high surf, and Captain Washington was the only one who had had an opportunity for examining any large number of the lifeboats on the coasts. I think that that committee were entitled to the greatest credit for undertaking such a responsible and laborious duty, and for the judicious manner in which they carried it out.

Having decided on the various qualities which a lifeboat ought to possess, they appropriated to each quality certain numbers proportionate to its importance, the total of all the numbers amounting to 100. To each design was then appropriated, after careful deliberation, the proportion of numbers on each quality to which it appeared entitled. To the design possessing the largest total of numbers it was decided to award the prize of 100*l.*, to which was added, by his Grace, another 100*l.* towards the cost of a full-sized boat on the selected plan. The prize was awarded by the Committee to Mr. James Beeching, boat-builder at Great Yarmouth.

A large boat, 36 feet long, and rowing 12 oars, was built from this design, which boat was afterwards purchased by the Ramsgate Harbour Commissioners, and a model of which is now on the table. An improvement in the mode of ballasting her was subsequently made, and since that time she has been one of the most frequently used and useful lifeboats in the United Kingdom. Some of the most gallant exploits performed by her crew will be familiar to many present through the medium of recent numbers of "MacMillan's Magazine." This was the first self-righting lifeboat.

The committee did not, however, propose the adoption of this boat, but deputed their member Mr. Peake to furnish a design for a lifeboat which should, to the best of his judgment, combine all the good qualities of the best of the designs that had been sent in. This was done, and a Report of the whole proceedings of the committee prepared, with drawings of the "prize-boat," and of several others to which high numbers had been awarded, as also the design furnished by Mr. Peake. The whole together, with other useful information on the subject, forming a handsome volume, was published at the expense of the Duke of Northumberland, and gratui-

tously presented by him to the competitors for the prize, and many others.

A boat from Mr. Peake's design was then built at Her Majesty's dock-yard at Woolwich, by direction of the Lords of the Admiralty, as a compliment, I believe, to the Duke of Northumberland. After a long series of trials, and after undergoing many alterations, this boat was completed and presented to his Grace, who had three others built similar to it at his own expense, and one on Beeching's design, with boathouses and transporting carriages complete, for the use of the fishing stations on the coast of Northumberland.

After these boats had been tested on the coast, by myself, in high surfs, the National Lifeboat Institution proceeded to build others on the same plan, although cautiously at first; which plan, with but slight modification and some improvement in form, it has continued to adopt up to the present time. It now possesses no less than one hundred self-righting boats, on this plan.

This boat has been called "Peake's Lifeboat;" it would, however, with more propriety be called "Beeching's Lifeboat, improved by Mr. Peake," or "The Northumberland Prize Lifeboat improved by Mr. Peake," it being a nearer resemblance to Beeching's prize-boat than to Mr. Peake's design as published in the "Northumberland Report" before alluded to.

Unfortunately, soon after the award of the prize to Mr. Beeching, accidents happened to three of his boats, which wellnigh smothered them altogether, and brought the very principle of self-righting, for a time, into disrepute. One of the requirements selected by the prize committee to which numbers were to be appropriated was lightness for land-transport; to meet which Mr. Beeching and several others, knowing that weight was required when afloat, adopted water-ballast, to be let in at the moment of launching. This ballast Mr. Beeching unfortunately did not secure properly, and three of the first boats built by him for another society upset through the leaking out of their water-ballast, when on their experimental trials with large sails set. From want of their ballast they did not self-right, and unhappily on two of those occasions lives were lost.

The self-righting principle was now at a discount, and many who from the first looked on it as the whimsical offspring of a theorist's brain, fit only to contend with storms on Utopian shores, now fully believed that the young visionary had already closed its earthly career. But its nurses thought otherwise, and, satisfied of its practical reality and vigorous growth, were noways disheartened, so, setting it again on its legs, they sent it forth to make its own way and prove its own worth. It has now a ten years' existence, and is certainly, as yet, shewing no signs of premature decay.

Since, as I have thought it just to shew that the sole authorship of the self-righting lifeboat now in use belongs neither to Mr. Peake nor Mr. Beeching, I have here designated it the "Self-righting Lifeboat of the National Lifeboat Institution."

Now it is not pretended that this boat is infallible—that it cannot be upset—or that it cannot be improved on. I fully believe that no boat can be built which will not be liable to upset under some circumstances. But, after going afloat in these boats numberless times in heavy surfs and being exactly acquainted with their character, I do not hesitate to give the

opinion that, taking them altogether, they are, as rowing boats, more suited for the service for which they are required, and safer to those who man them, than any other description of boat in use. In continuing to adopt this class of boat in preference to any other, the Institution has not been influenced by my reports of them alone, but by the encomiums of the crews who work them; by the noble services they have rendered to shipwrecked persons; by their numberless successes and few failures; and by the results of the few accidents which have happened to them.

Since their first adoption, six of these boats have been upset and one put *hors de combat:* four of that number being a small class of single-banked boat, rowing but six oars, which are placed at stations where there are not local means for managing the larger double-banked boats.

IV.—*Accidents to Lifeboats.*

These accidents were as follows:—

1st. *Lyme Regis.*—On the 7th January, 1854, the Lyme Regis lifeboat was upset by the falling over of a French schooner upon her, the schooner's deck cargo of casks of wine being dashed with violence into the boat. Although this boat was seriously damaged, and was for a time held down by the vessel's sails so that she could not self-right, she was righted after the sails and gear which held her down were cut away, and the crew of the French vessel and the boat's crew were safely carried to shore by her, with the exception of one of the latter, who had unfortunately untied his lifebelt, and was last seen struggling amongst the *debris* of the wreck. Had the boat not been a self-righting one, all hands would undoubtedly have perished, the accident happening at a considerable distance from the land.

2nd. *Dungeness.*—On the 19th October, 1858, in the middle of the night, the small six-oared Dungeness lifeboat upset, by broaching to when running through a heavy surf on her return from a deserted wreck. Her crew, eight in number, were thrown into the water, but she instantly righted again, when they all got into her and returned in her safely to shore, reporting themselves to the officer of coastguard at the station as ready to go out in her again at any moment their services might be required.

3rd. *Aldborough.*—On the 3rd of January, 1860, the Aldborough lifeboat was hauling off the beach by an anchor and warp to proceed to a stranded vessel when a tremendous surf struck her, tore the warp out of the hands of the crew who were hauling her off, and upset her. Fifteen men were in her, of whom fourteen were thrown into the sea and one remained in the boat, clinging to a thwart.

The masts, which were up, broke off on coming in contact with the ground, and the boat directly righted again. Some of the crew were thrown 30 yards or more from the boat by the sea which upset her. Four of them made for the shore; the other ten returned to the boat. Unfortunately the weather was so intensely cold, the snow being a foot deep at the time, that, although the crew supported by their lifebelts were able to regain the boat, their blood was so chilled and their limbs so paralysed,

that they could not unaided get into her again. The one man who had gone round with her, and who was not even entirely wet through, aided nine men into the boat, but the tenth man was by that time so benumbed with cold that, finding himself unable to retain his grasp of the life-lines round the boat with his hands, he seized one of them between his teeth. Sad to say, however, before the man within the boat was able to assist him, a heavy lurch of the boat tore his teeth from the jaw and he was carried away. Two of the four men who had made for the shore were with difficulty rescued from the breakers on the beach, but the two others and the poor man with the broken jaw perished from cold. Supported by their lifebelts, the bodies were swept by the tide to the north, within a short distance of the shore, and followed by a large crowd of persons; but when at last they were got to the beach, a mile northward of the site of the accident, life was extinct.

4th. Ardmore, Ireland.—On the 6th of November, 1860, the Ardmore small six-oared lifeboat when out for exercise was returning to the shore through a very high surf, when, too much way having been given to her, she ran on a sea, broached-to, and upset. Her crew of eight men, with three amateurs, one of them the local honorary secretary, were thrown into the sea, but she self-righted, and they all regained her, and returned safely to the shore.

5th. Tramore, Ireland.—On the 17th February, 1861, the Tramore six-oared lifeboat, when attempting to save the crew of a wrecked vessel, was upset, and her crew, eight in number, were thrown out of her; she directly self-righted, and a portion of them got into her again; the remainder swam to the shore supported by their belts. She afterwards saved some of the wrecked men, and a few days after saved the crew of another wrecked vessel.

6th. Calais.—On the 28th February, 1859, the small six-oared lifeboat which had been presented to the town of Calais by the English government, got stove-in alongside a stranded steamer off Calais; becoming partially filled with water, her stability was thereby injured, and those who got into her from the steamer, all getting to her further side, from fear of injury by her striking against the vessel, her off gunwale was put under water, and, a sea breaking over it at the time, she upset; she righted again, but three out of seven persons who had got into her, and had on no lifebelts, unhappily perished. A mixed crew of English and French, and great mismanagement throughout, occasioned this accident.

7th. Scarborough.—On the 3rd November, 1861, the Scarborough, 32 feet ten-oared self-righting lifeboat, which had been only a few weeks on her station, was proceeding to a wrecked vessel, stranded very close to the shore, when she got into a very high and irregular surf, caused by the rebound of the waves from a sea-wall. Her motion became so violent that the steersman was thrown overboard, and the crew, in attempting to save him, got into a still worse position, and, some of their oars getting broken and knocked out of their hands, she became unmanageable, and was dashed several times with terrific violence against the sea-wall, her crew being all thrown out of her in succession. This accident is of so recent a date that the circumstances of it will be fresh in the memory of every one; the newspapers having recorded all its details. It will suffice, therefore, to

state that, to the astonishment of all present, the boat did not upset, and was not broken to pieces ; that one of her crew was crushed between the boat and the wall, which caused his death; and that one was drowned, he being the only one who had unfortunately neglected to put on his lifebelt.

The above are the only serious accidents that have occurred to this class of boats ; for those to the first experimental and immatured lifeboats of Mr. Beaching cannot be fairly included in the category.

The result of the seven accidents above enumerated are, that out of 82 persons who were in the boats when the accidents occurred to them only 9 perished; 3 from cold, 2 from injury, and 4 from drowning through not having on lifebelts. Now, had not these boats been self-righting, and had not their crews been supplied with good lifebelts, how much larger a number would indubitably have perished!

As a contrast, we have, during the last eleven years only, the upsetting of the Shields lifeboat in 1849, with the loss of 20 out of 24 of her crew. On the 4th January, 1857, the upsetting of the Point of Ayr lifeboat, on the Liverpool plan, when her whole crew of 13 men perished. And, lastly, the upsetting, on the 9th February, 1861, of the Whitby lifeboat, when 12 out of 13 of her crew perished. Giving a total of 45 lives lost, out of 50, by these three accidents alone.

With such an extraordinary contrast in the results of accidents to self-righting and non-righting lifeboats, who will venture to say that the principle of self-righting is a chimera, or that it is any other than a great practical and valuable truth?

No less than 135 of these self-righting lifeboats have been built during the last ten years by the Messrs. Forrest, of Limehouse, builders to the Institution, of which number 30 have been for foreign governments or for our colonial and foreign possessions. They have, during the same period, saved several hundred lives on our own coasts, and have rendered other valuable services to wrecked vessels.

4. *Richardson's Tubular Lifeboat.*—The next coast lifeboat to be described is "the tubular." By the model of this boat, which is on the table, it will be seen that it is altogether different in principle to any other boat; consisting of two long tubes running parallel to each other a few feet apart, having their ends turned upwards and inwards, and terminating in points, with an open-work or grating deck with corresponding thwarts, all supported above the tubes.

The boat of which this is a model was built in 1852 by Messrs. H. and H. T. Richardson, two Welsh gentlemen, father and son. They had for many years had a small boat of the same class in use on a lake in Wales, and, when the Duke of Northumberland offered the prize for the best design of a lifeboat in 1850, they sent the model, which is now on the table, to compete for it. With much public spirit they then built at Manchester a full-sized boat, 40 feet long, and rowing 14 oars, and made a coasting voyage in it themselves from Liverpool to the Thames, putting into most of the intermediate ports. In a half-comic, half-serious, account which they published of this voyage, under the title of "The Cruize of the Challenger," she was described as having encountered extraordinary dangers, and displayed marvellous properties. Her designers further chal-

lenged all the lifeboats in the kingdom to compete with her. But, as I have stated under a previous heading, there are almost insuperable difficulties in the way of competitive trials of lifeboats. As it was, I believe these gentlemen spent considerably more than 1,000*l.* in the building and exhibiting of this boat, yet they were unable to obtain any trial of her in competition with other lifeboats.

I should myself much like to see a competitive trial of the different descriptions of coast lifeboats, including this one, in a gale of wind and heavy surf, but such a trial could only be undertaken by the Government. It would have to come off at some large port, such as Shields, where plenty of boatmen acquainted with lifeboat work would be available, and where, from the contiguity of lifeboat stations, some boats could be got together without much difficulty or other expense than the payment of men for trying them. Still, the tubular at least would have to be expressly built for the trial and to be sent from a distance, so that I doubt if the whole trial, which, to be conclusive, might have to be more than once repeated, could be gone through at a less cost than 1,000*l.*; and even then there might be great difficulty in procuring equally effective crews for all the boats, which would be essential. Again, it would be necessary, in the event of any lives being lost in such a series of trials, to secure a permanent provision for any widows and orphans who might be left, which could be done by Government alone.

The tubular lifeboat built by the Messrs. Richardson in 1851 was afterwards sold by them to the Portuguese Government, to be stationed at the city of Oporto, off the port of which there is a very dangerous bar.

Another somewhat smaller tubular boat was, in 1856, built for the National Lifeboat Institution, and stationed at Rhyl, the boatmen at which place had applied for such a boat. She has since that time saved several wrecked crews, and has been very highly reported on by those who work her. She has necessarily very great stability, and the advantage of instantaneously discharging all water that breaks over her. She also tows very steadily; but that is a quality not often brought into requisition.

The obstacles which have stood in the way of a further trial of these boats have been:—

1. The uncertainty of the boatmen on the coast taking to a boat so different from an ordinary one.

2. The uncertainty of their durability, and their liability to damage by collision with the ground, the material of which they are made being tinned iron, which is very easily indented or cut through.

3. Their requiring a very clumsy and heavy transporting carriage.

I have had no opportunity for going afloat in this boat in any very heavy surf, so can offer no practical opinion respecting her; but she rows faster in a moderate sea than I should have anticipated.

Should any further trials be made of this class of boat, it might be worth while to have one made of wood instead of metal tubing.

5. *Whyte's Lifeboat.*—The last description of lifeboat which I have to describe is that of the well-known yacht-builder Mr. Whyte of Cowes. This boat competed for the Northumberland prize in 1851 as Lamb and Whyte's lifeboat. It is mostly in use as a ship's lifeboat, chiefly on

board the vessels of some of the large steam-packet companies.* I believe it to be the best ship's lifeboat yet adopted; but as a coast lifeboat it is not considered to possess sufficient "extra buoyancy," or means for self-discharge of water; it has not, therefore, come into general use, although it is very fast both as a rowing and a sailing boat. There are only two lifeboat stations provided with it, and there are three others in the hands of the boatmen on the Kentish coast, where they are available to save lives as well as to serve their owner's purposes.

V.—*Modes of Propulsion.*

Having explained the general properties of lifeboats, as exemplified in those principally in use on the coasts of the united kingdom, the not uninteresting question arises as to what is the most advantageous mode of propelling them—I mean by manual labour; for, although for the performance of services at very long distances sails must be employed, and in a few localities where boats are stationed in harbours steam-vessels may be available to tow them, yet, as, at nine stations out of every ten, lifeboats have to be launched from an open, exposed, and generally flat beach through a heavy surf, and have to proceed entirely through broken water, the manual labour of their crews is the only possible mode of propelling them.

It would perhaps not have been worth while to moot this question at all, but that it happens to be one of the most favourite notions of inventors, and of even some scientific persons, that a lifeboat could be propelled more rapidly by revolving paddles or screws, worked by winches within the boat, than by oars.

Those who take up this notion too often forget the mechanical law, that by no possible arrangement or application of machinery or leverage can the power or strength of one individual person, or any other power, be really multiplied. They forget that, if by leverage or tackle-purchase an individual can be enabled to lift or drag a weight 100 times greater than by his unaided strength, he can only move the same through a hundredth part of the same space in a given time, and that what therefore is apparently gained in power is lost in time or speed.

The question then really at issue is, not—How shall the power of a boat's crew be multiplied? but—How can the actual power which they do possess be most advantageously applied?

A few minutes' consideration must, I am sure, convince any one, that, ancient as is the mode of propelling boats by oars, no more beautiful and convenient instrument than an oar could be devised for the purpose.

Undoubtedly, where great velocity as well as power can be obtained by extraordinary mechanical force, such as that of steam, the rotatory motion

* The Lords of the Admiralty have recently ordered a lifeboat on this plan to be provided for every man-of-war stationed on the west coast of Africa.

It is much to be desired that every ship of war should be provided with a good lifeboat. Many valuable lives, both of officers and men, have been lost for want of boats that could be safely lowered in a gale of wind at sea, or taken through a surf on the shore or bar of a river with impunity.

of the wheel has great advantages; but even as applied to the propulsion of large vessels by the ordinary paddles, or by the oblique blades commonly termed screws, great loss of power occurs when a vessel is subjected to much motion in a heavy sea, so that frequently no headway can be made; for in a paddle-steamer one paddle will be frequently revolving in the air and the other be too deeply immersed, whilst in a screw-vessel the blades will be often partially out of water and their force considerably diverge from a horizontal line.

But a lifeboat in a heavy surf is subjected to motion so much more violent and excessive in amount than a large vessel is liable to in an open sea, that, even if it were possible to work the former by steam, the loss of power would be so great as to stop all progress. What then could the much more limited power of ten or twelve men avail under the same circumstances, even if they were accustomed to exert those particular muscles which are brought into use in turning a rotatory machine?

The advantages of the oar are—

1st. That it is worked with less loss of power from friction by manual labour than would be any rotatory instrument.

2nd. That, in the hands of a skilful rower, it is always worked at full power; its blade, in obedience to the quick eye and steady hand, following the upheaving or downfalling wave, and, in measured time, cleaving its varied surface with the whole force of the broad chest and muscular arm directing it.

3rd. That, being in daily use by the coast boatmen in pursuing their own avocations, they are not only already skilled in its management, but have those particular muscles which are required to work it already strengthened by use.

In truth, this last reason alone for its preference is a sufficient reply to all advocates of the paddle or screw, and, consequently, my usual reply to inventors or others who suggest the employment of either of the latter is, that, if they can secure for us at each lifeboat station a corps of men whose daily work is that of turning winches, or grindstones, the question may then be open to consideration.

VI.—*Equipment.*

Having settled the principles on which a lifeboat should be constructed, and decided on the mode of propelling her, we have now to equip her for service. In doing so we have, as a first duty, to provide her with everything that can contribute to the safety of those whose lives we jeopardise by employing them on this dangerous service; secondly, to make her as far as possible independent of all assistance from wrecked vessels, the crews of which are often in a helpless state, perhaps lashed to the rigging, and unable to throw a rope, or even to get from the wreck to the boat without aid.

A lifeboat is therefore provided with lines, called life-lines, some festooned round her sides, by the aid of which any one in the water using them as stirrups can get into her; others with corks attached are thrown from within her when alongside a wreck, and float on the water all around her. She is also furnished with a cork lifebuoy, which, with a line

attached, can be thrown or floated to any one in the water who might be too distant to reach the life-lines of the boat. She has likewise strong but light lines with grappling-irons attached, one at the bow and another at the stern, which, by being thrown into the rigging or on board a wreck, fasten themselves, so that the boat can be at once held to the wreck without the assistance of any one in her. An anchor and cable; a good lantern for nightwork; a compass; and a drogue or water-bag, which is dragged behind a boat to prevent "broaching-to" when running before a heavy sea, are also necessary to a complete equipment; and last, but not least, is the supply of a good life-belt, or life-jacket as it is sometimes called, to each of the boat's crew.

As the life-belt is an especial hobby of my own, and as the description with which the boats' crews of the National Lifeboat Institution are provided was designed by myself, I trust I shall not be tempted to be wearisome to my hearers; but, since I consider the subject to be one of the utmost importance, I shall at some length remark on it.

One of the causes of the great loss of life which attended most lifeboat accidents in the olden time, independently of the boats not possessing the self-righting property, was undoubtedly that their crews were not provided with life-belts, or, as in the case of the late Whitby lifeboat, that those they had were of a worthless description.

The cases of accident which I have already quoted under the head of self-righting, are equally illustrative of the value of good life-belts, for, unless in each case the men had been supported by their belts, the self-righting property would have been of no service to many of them. For it must be remembered that the majority of our coast boatmen cannot swim, and that even the best swimmers forfeit their lives, when upset in heavy surfs, through losing their presence of mind. Many cases could be quoted, but none more conclusive than that of the Southwold boat before referred to, when three gentlemen without belts were drowned, although one of them was known to be a good swimmer, whilst 15 men having on belts, several of whom could not swim, were all saved. And again, that of the Whitby boat, when one man who had on a good belt, although unable to swim, was saved, whilst 12 who had on inferior ones were drowned. How many lives might be saved annually if one of these belts was provided for the master and each man in our merchant ships!

The requisite qualities of a lifeboatman's life-belt are—

1. Sufficient extra-buoyancy to support a man heavily clothed, with his head and shoulders above the water, or to enable him to support another person besides himself.

2. Perfect flexibility, so as to readily conform to the shape of the wearer.

3. A division into two zones, an upper and lower, so that between the two it may be secured tightly round the waist; for in no other manner can it be confined sufficiently close and secure round the body without such pressure over the chest and ribs as to materially affect the free action of the lungs, impede the muscular movement of the chest and arms, and thereby diminish the power of endurance of fatigue, which, in rowing boats, is a matter of vital importance.

4. Strength, durability, and non-liability to injury.

With the help of the different life-belts on the table, I hope to be able to

show that the cork belt designed by myself, and which is supplied to all the lifeboats' crews of the National Lifeboat Institution, possesses the first two qualities in a greater degree than any other life-belt, and the third one exclusively. (*Vide* fig. below.)

The belt I hold in my hand is one of this description. Its extra-buoyancy is equal to about 25 lbs. It will support an ordinary man, with his clothes on, with the shoulders and chest above the water. The most buoyant of the old descriptions of cork belt (Carte's) had extra-buoyancy equivalent to about 14 lbs. but many of them not more than 7 or 8 lbs. The largest size of the ordinary inflated belts has buoyancy equal to 20 lbs. when completely inflated; some not more than 8 or 10 lbs.

The defects of all inflated air-belts, are, their liability to puncture, want of strength, want of flexibility if more than half inflated, difficulty of inflation in very cold weather, and the liability of their inflating-valves to get out of order by corrosion from the effects of salt water. Some of these defects were partially remedied in an inflated belt designed by myself, in four compartments. This belt had extra-buoyancy equal to from 30 to 35 lbs.; so that, if two of its compartments were injured, the remaining two would suffice to support one person. But the insufficient strength of all belts of this class, and the difficulty of inflating them in cold weather, made it evident that an efficient life-belt was a desideratum yet unattained.

Up to that time (1854) there was no cork belt having sufficient buoyancy, or flexibility, or strength. The only solid cork belt was composed of a

single row of either rectangular blocks of cork sewn up in a cotton jean covering, or pads of cork-shavings or dust.

In that year, however, it fortunately occurred to me to attach narrow uncovered ribs of cork to a strong backing or broad belt, each piece being separately sewn on by strong twine, in such a manner that the breaking off of any one piece would not loosen that next to it, whilst one surface only of the corks being attached to the belt, afforded perfect flexibility. An examination of this belt cannot fail to convince any one that it possesses all the qualities already pointed out to be necessary, and that it has the further advantage of affording great protection to the body of the wearer.

Upwards of 3600 of these belts have now been issued, nearly half of which are at the lifeboat establishments of the National Lifeboat Institution. On the occasions of quarterly exercise in the summer months, the lifeboat men not uncommonly jump overboard to test the belts, and they have everywhere great confidence in them. After the fatal accident to the Whitby lifeboat, I was at Whitby, and questioned the only man who was saved, and who was the only one who had on one of these belts. I asked him if he had any difficulty, amongst the heavy surf, in keeping his feet down and his head well above the surface. In reply, he stated that after the first sea broke over him he found himself so quickly raised above the water again, that, although unable to swim, he entertained no doubt of his safety, and lost all fear.

There are other descriptions of life-belts on the table, which will show the different ideas on the subject that have occurred to different persons.

Transporting Carriage.

There is one other very important auxiliary to a lifeboat, which has to be noticed, viz. a carriage. Every lifeboat, except a few of the largest size, is provided with a carriage, on which she is kept in the boat-house ready for immediate transportation to the most favourable position for launching to a wreck. A lifeboat is thus made available for a greater extent of coast than she otherwise would be, and even when launched from abreast of the boat-house can be much quicker conveyed to the water's edge than she could be if not on a carriage. In addition to this ordinary use, a carriage is of immense service in launching a boat from a beach, to that extent indeed, that one can be readily launched from a carriage through a high surf, when without one she could not be got off the beach. An explanation of the manner in which this service is performed will be readily understood.

The lifeboat is drawn to the water's edge, where the carriage is turned round so that its rear end, from which the boat is launched, shall face to seaward. The crew then take their seats in the boat, each rower in his place with his oar over the side, and the coxswain at the helm or with the steering-oar in hand. The carriage is then backed by men or horses or both, sufficiently far into the water to ensure the boat being afloat when she is run off the carriage; or, if the ground be very soft, or sufficient help unobtainable, the carriage is first backed far enough into the water before the crew get into her. Self-detaching ropes, termed launching ropes, pre-

viously hooked to each side of the boat's sternpost, and rove through sheaves at the rear end of the carriage, are then led up the beach, and either manned by assistants or have one or more horses attached to them.

When all is ready, the coxswain, watching a favourable moment, gives the word, and the boat, the keel of which rests on small iron rollers, is run off rapidly into the water with her bow facing the surf. The oarsmen then give way, even before her stern has left the carriage, and she is at once under command, ere the sea has time to throw her back broadside to the shore, which is usually the effect of attempting to launch through a surf from an open beach without a carriage, unless a hauling-off warp attached to an anchor be permanently laid down outside the surf. This latter plan is only available in a few localities where there is a comparatively steep beach.

There are different descriptions of lifeboat carriages, but those which are now almost universally provided are on a plan designed by myself (Plate IV.), of which there is also a model on the table. It has advantages over any others that I am acquainted with: a chief peculiarity being that by detaching the fore-body the fore end of the keelway rests on the ground, forming a gradual incline up which the boat is hauled bow-foremost to replace her on the carriage, instead of hauling her up stern foremost at the rear end as in other carriages, the former arrangement being more convenient and less laborious.

A set of portable skids (Plate V.), one being fitted as a turn-table, on which the boat is hauled out of the water, before replacing her on her carriage, completes the usual equipment of a lifeboat. The boats of the National Life Boat Institution, and all belonging to them, are kept in roomy and substantial boathouses under lock and key, in charge of paid coxswains, under the general superintendence of local honorary committees of residents in the several localities.

VII.—*Review of the whole system of saving lives from Shipwreck on the Coasts of the United Kingdom.*

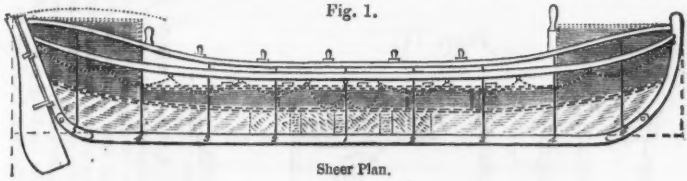
It now only remains to pass briefly in review the machinery which has been and is in use on the coasts of this great maritime country for the preservation of human lives from shipwreck; that is to say, the machinery expressly provided for that purpose.

Wrecked persons can be saved from the shore by two modes. They may be taken off a wreck by a lifeboat, or may be drawn to the shore along a rope conveyed to the wreck by the now well-known rocket and mortar life-saving apparatus. A model of the rocket apparatus in use may be seen in the Museum of this Institution. The provision of that apparatus on all those parts of the coast where it is likely to be useful is undertaken by the Board of Trade from the Mercantile Marine Fund, and placed under the management of the coast-guard. It is now kept in a most efficient state, the men being periodically practised in its use, and an average of about 300 lives are saved annually through its instrumentality. It is mostly useful at places where lifeboats cannot be stationed. Manby's Mortar and Dennett's Rocket apparatus have been in general use since the early part of the present century.

Plate III.

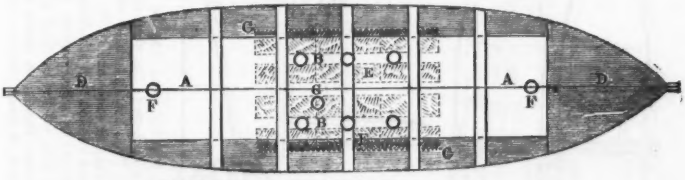
THE LIFEBOAT OF THE ROYAL NATIONAL LIFEBOAT INSTITUTION.

Fig. 1.



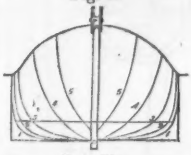
Sheer Plan.

Fig. 2.



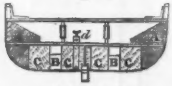
Deck Plan.

Fig. 3.



Body Plan.

Fig. 4.



Midship Section.

The accompanying figures show the general form, the nature of the fittings, and air-chambers of one of these boats, 33 feet in length and 8 feet in breadth. In figs. 1 and 2, the elevation and deck plans, the general exterior form of the boat is shown with the sheer of gunwale, length of keel, and rake of stem and stern-posts. The dotted lines of fig. 1 show the position and dimensions of the air-chambers within board, the relieving-tubes, and ballast. In fig. 2, A represents the deck, B the relieving-tubes (6 inches in diameter), C the side air-cases, D the end air-chambers, E ballast, F ventilators to admit of a free current of air under the water-tight deck, G ventilator to receive pump. In fig. 3, the exterior form of transverse sections, at different distances from stem to stern, is shown. Fig. 4 represents a midship transverse section, A being sections of the side air-cases; B the relieving-tubes, of the same depth as the space between the deck and the boat's floor; C, C, C, C, are spaces beneath the deck, 9 feet in length, placed longitudinally at the midship part of the boat, with solid chocks of light wood, or cases packed with cork, forming a portion of the ballast; *d* is a ventilator, having a pump fixed in it, by which any leakage can be pumped out by one of the crew whilst afloat. The festooned lines in fig. 1 represent exterior life-lines attached round the entire length of the boat, to which persons in the water may cling till they can be got into the boat; the two central lines are festooned lower than the others, to be used as stirrups, so that a person in the water, by stepping on them, may climb into the boat.

This life-boat possesses in the highest degree all the qualities which it is desirable that a life-boat should possess:—

1. Great lateral stability.
2. Speed against a heavy sea.
3. Facility for launching and for taking the shore.
4. Immediate self-discharge of any water breaking into her.
5. The important advantage of self-righting if upset.
6. Strength.
7. Stowage-room for a number of passengers.

LIFE-BOAT TRANSPORTING CARRIAGE.

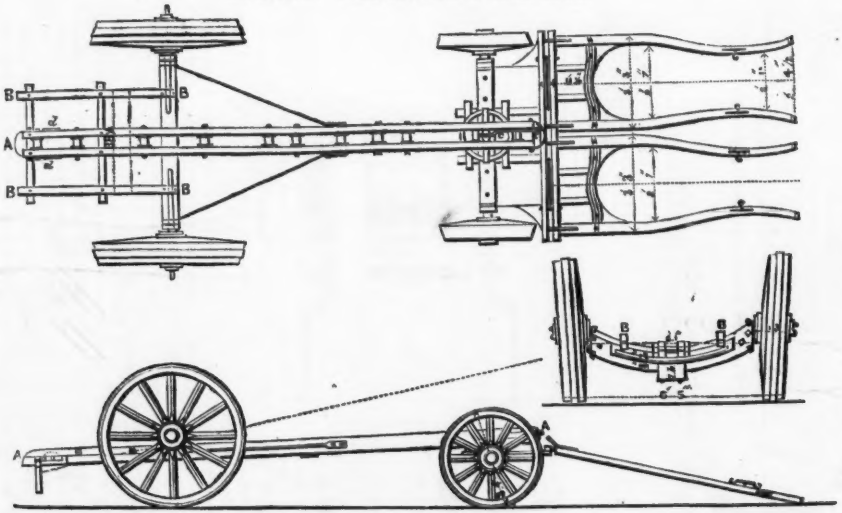
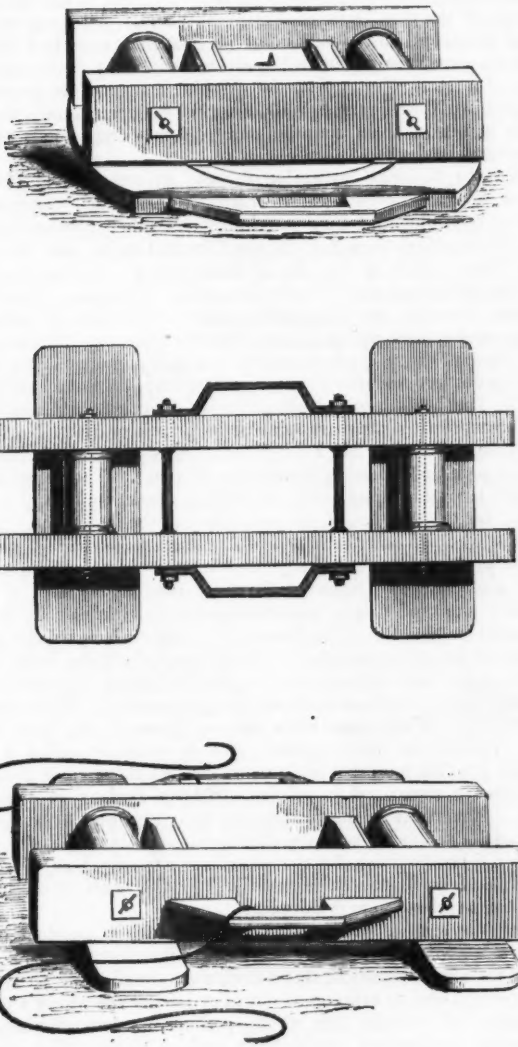


PLATE IV.

The carriage consists of a fore and main body. The latter is formed of a keelway A, A, and of side or bilgeways B, B, in rear of the main axle, the boat's weight being entirely on the rollers of the keelway. Its leading characteristic is, that, on the withdrawal of the long fore-lock pin *c*, the fore and main bodies can be detached from each other. The advantages of this arrangement are that the weight of the boat when she is launched from the rear end forms an inclined plane by elevating the keelway, yet without lifting the fore body off the ground, whilst to replace her on the carriage she can be hauled bow foremost up the fore end or longer incline. The bilgeways B, B, are needed at the rear end, that the boat may be launched in an upright position with her crew on board; but they are not required at the fore end of the carriage. The boat is hauled off the carriage and launched into the sea by a rope at each end of the boat rove through the sheeve *d*, having one end hooked to a self-detaching hook at the boat's stern, and the other manned by a few persons on the shore, who thus haul the boat and her crew off the carriage and launch them afloat at once with their oars in their hands, by which means head-way may be obtained before the breakers have time to beat the boat broadside on to the beach.

PLATE V.



The first lifeboat was that built in the year 1789 by Mr. Greathead at Shields. The utility of this boat being proved, she was soon followed by others, the second one being built in the following year, at the same port, at the expense of the then Duke of Northumberland. All the ports on the north-east coast, and on the east coast of Scotland, soon had their lifeboats, which were mostly provided and maintained by funds collected in the shape of a small voluntary tax on shipping entering the several ports. In Lincolnshire, Norfolk, and Suffolk, associations were formed which provided the coasts of these counties with lifeboats from funds raised by voluntary contributions.

In 1824 the National Institution for the Preservation of Lives from Shipwreck, now the Royal National Lifeboat Institution, was established in London by influential City merchants and other gentlemen, the late Thomas Wilson, Esq., then M.P. for the City of London, and the late Sir William Hillary, Bart., of the Isle of Man, taking a leading part in it; and His Majesty George the Fourth becoming its patron. That institution granted honorary and pecuniary rewards for services in saving lives from shipwrecks, and assisted local bodies in placing lifeboats on the coasts. Some of those boats remained nominally in connection with it, but the institution undertook no superintendence or control of them on the coast. The boats mostly built under its direction were small single-banked boats rowing six oars, similar in principle to the Norfolk and Suffolk sailing lifeboats; but having more water-space within them, and insufficient means of relieving themselves of water. They were designed by the late George Palmer, Esq., of Nazing Park, for many years an active and zealous member of the committee of the institution. Some of them, stationed chiefly on the Island of Anglesea, rendered good service.

As time went on, however, the general interest in the lifeboat service seems to have waned. Some of the local associations died a natural death. For want of proper superintendence the lifeboats in too many instances were suffered to go to decay. At places where wrecks were not very frequent the boats remained for many months without being put into the water, and in consequence, when wrecks did happen, the local boatmen felt no confidence in them, and would in preference go off to wrecks in their own boats. There were often also no funds to pay them for their services. In fact the whole system, if that could be called a system which had no general organisation, had broken down, and there were, perhaps, not a dozen really efficient lifeboat stations in the United Kingdom. The National Institution was also becoming every year less known, and its resources annually diminishing. Meanwhile, the number of wrecks did not diminish, for the winter's storms raged as of yore, and the increase of trade almost necessarily brought with it an increased number of casualties amongst shipping.

Such was the state of things when in 1849 the fatal accident occurred to the Shields lifeboat, by which twenty brave men lost their lives.

But, as we often witness in this world, on a small scale as well as a great, it pleased God to bring good out of evil—and the widow's wail and the orphan's cry wrought that which, perhaps, no less affecting, no less heart-rending a stimulant would have sufficed to do. The immediate effect of that melancholy incident was the resuscitation of the society

already referred to, now to become the truly *national* institution which it is this day. I am not now about to relate, in detail, its history. It will suffice to say that in the year following that disaster it aroused itself from sleep; its managing committee was invigorated by new, and younger, and some professional blood. The Duke of Northumberland accepted the office of its president; Her Majesty the Queen being already its patron, and His Royal Highness the late lamented Prince Consort one of its vice-patrons. Its present zealous and able secretary, Mr. Lewis, was appointed. It commenced the building of that fleet of lifeboats which now encircles our shores, numbering no less than 121, more completely and efficiently equipped than ever were lifeboat establishments before; which have cost nearly 50,000*l.*, and have already saved nearly 1,000 lives. It undertook the immediate superintendence of that fleet through the instrumentality of an honorary local committee at every station, a periodical inspection by an officer of its own, with a system of quarterly and especial reports from its local committees to the central one in London. It established a fixed scale of salaries to the coxswains, and of payments to the crews of its lifeboats, both for services to wrecked persons, and for a quarterly exercise in its boats. Finally, by the tangible, visible effects of its exertions, it succeeded in enlisting that public sympathy and support which in this country is happily so open-handed when shewn to be really required, and which have made it, and now uphold it, as one of the most glorious institutions of our land.

As an officer of the institution, I am not in a position to name those of its committee of management who have especially devoted time and labour gratuitously to this great work. Some of them have gone to their reward; those who are still amongst us will feel their chief compensation to be in the approval of their own consciences, and at the prospect of the good in the performance of which it has been their privilege to take a part.

Despite, however, this fleet of 121 lifeboats, and of 48 others locally provided and supported; and despite the numerous rocket and mortar stations on our coasts; there remains the melancholy fact, that an average of 800 lives are lost annually on and around our own shores alone, proclaiming, solemnly though silently, that for humanity's sake, and for the national credit, no exertions should be spared in providing every possible means for the conveyance of succour to the shipwrecked, from the shore; and also proclaiming in still more eloquent if not indignant terms, that some attempt should be made towards providing for the greater safety of the seamen in our home and coasting trade, by the adoption of measures both precautionary and remedial on board our merchant vessels themselves.

Friday, January 24th, 1862.

Lieut.-General the Honourable Sir EDWARD CUST, K.C.H.,
in the Chair.

OUTPOST DUTIES.

By Colonel R. Wilbraham, C.B., Governor, General Hospital, Woolwich.

It is, I assure you, with unfeigned diffidence that I have undertaken the task of delivering a lecture here to-day on Outpost Duties.

In the flattering invitation which I received from your Council to lecture before this Institution, the choice of subject was not left to me, or I should scarcely have ventured to select one which is at once so important, and so difficult to treat, as that which has been entrusted to me.

The incalculable importance of the efficient performance of these duties is well summed up in a few words by Marshal Bugeaud. "A good system of outposts," he remarks, "should not only guarantee an army against surprise, but should give it the power of refusing an engagement by a timely retreat—in a word, of fighting only when and where it pleases."

With the exception of the scientific branches of military education, the most difficult attainment of a soldier is, without doubt, a thorough knowledge of the varied duties of light troops. If we look through the military annals of our own and other countries, we shall find how rare are the instances of officers who have thoroughly mastered this part of their professional training. In our own service, when we have named Sir John Moore—the creator, as he may be called, of our light infantry system—and a few of his aptest scholars—such men as Sir Sydney Beckwith and Lord Seaton—we have, perhaps, named all who have distinguished themselves above their companions in arms as light infantry officers.

Among the Germans there are several names which will readily occur to many of my hearers—such as those of Thielmann and Lutzow in the War of Liberation in 1813—though their exploits belong, perhaps, rather to the separate field of partizan warfare. I may, however, instance Marshal Blücher, whose indomitable energy and enterprise made him especially dreaded by the French outposts in the early campaigns of the Revolutionary War.

No amount of mere instruction will make a first-rate light infantry officer, unless it be combined with natural intelligence and a good eye for a country; but, at the same time, instruction, and, still more, the instruction of experience, will greatly improve every one, whether officer or

soldier. The result of the first may be seen in the immeasurable superiority of the light troops which had the benefit of Sir John Moore's training in the camp at Shorncliffe—regiments taken at hazard from the whole British army; that of the second, in the unrivalled excellence of the Light Division in the later campaigns of the Peninsular war.

It would be needless before an exclusively military audience to expose the fallacy, too prevalent among us of late, of supposing that a lesser amount of training will suffice to render soldiers fit to act as light infantry than would be required to enable them to take their place in the line. Those who hazard such an opinion are misled by the facility with which the parade movements of light infantry may be learnt by zealous and intelligent men. They forget, or rather they are not aware, how small a part these movements form of the education of light troops—how valueless they are unless grafted on the steadiest battalion drill. Confidence in themselves and in their comrades will alone enable them to skirmish with vigour; to keep up their fire with coolness as long as their post is tenable; to fall back without confusion when outnumbered; to oppose a solid wall to the most sudden attack of cavalry;—and this confidence is, as every soldier knows, the slow growth of discipline and drill.

Raw and inexperienced troops have won great battles—perhaps, in some cases, they may even do better than older soldiers, from not fully appreciating their danger; but writers on military science, of all nations, agree that, for the adequate performance of outpost duties, the most careful selection of troops is requisite. One of the highest authorities on these matters—the Prussian general, Decker, whose treatise on the secondary operations of war has become a text-book in all European armies—expresses himself in the following strong terms: "To make 'la petite guerre'" (it would not be easy to translate this phrase into English, but it conveys its own meaning), "to make 'la petite guerre' with newly-raised troops and uninstructed officers would be a most difficult undertaking, and one from which it would be hopeless to expect success."

It is, I trust, needless for me to say that I do not make these remarks in any degree in disparagement of our Volunteers, but merely to prove, what I have often told them to their face, that, in the event of their being called into the field against an invading army, composed, as that army would assuredly be, of the very choicest troops, their chief value will be found, not as light infantry for the difficult duty of outposts, but as troops of position in support of, or side by side with, troops of the line.

All that zeal, and intelligence, and pluck can do, I give them full credit for doing; but it would be virtually denying the necessity of the army as a profession if we were to admit that those who devote a few leisure hours to their military duties could perform the most difficult of those duties as well as those who make it the study of their lives, and, from what I know of the volunteers, I feel sure that they themselves would be the first to acknowledge the justice of Decker's remarks.

As I was given to understand that my audience would, in all probability, comprise but few young officers, I have not attempted to lay down any regular system of instruction for the performance of outpost duties. Even had it been otherwise, I should have preferred endeavouring to awaken in them an interest in the subject, which would lead them to study it for

themselves in those standard works which are now within every officer's reach. I have, therefore, thought it better to make such general observations on the province of light troops as suggested themselves to me, either from reading or from personal experience, illustrating them by examples drawn from military history. By this course, I hope, while conveying at least indirect instruction, to make my lecture not altogether without interest to a mixed audience.

Indeed, the definite rules for the guidance of officers on piquet may be reduced to very few. In our own Book of Field Exercise these rules are laid down very clearly and concisely, and, if carefully read, would give a young officer a very fair insight into the theory of outpost duty. But this is a branch of a soldier's education which, more than any other, needs to be learnt, not by theory only, but by practice.

Did one not know by experience how often the most self-evident axioms of war are neglected or contravened even by those who ought to know better, one would be tempted to smile at the simplicity of some of the rules laid down, and even strongly and repeatedly enforced, in the elementary works of all nations, such, for instance, as exhortations to vigilance, which, one would think, ought to be unneeded in presence of an enemy, or the recommendation of precautions such as one would suppose must occur to the mind of even the most inexperienced. But when we see that master-minds like Frederick the Great, in their instructions to the officers under their command, consider no detail too trivial to dwell upon, we cannot but recognise the wisdom of endeavouring to supply by rules the want of that foresight and presence of mind which are so needful in service of this nature, but the possession of which is so rare a gift.

The systems of different services are becoming gradually more and more assimilated, as might naturally be expected from the experience of their comparative excellence during the long wars of the Empire. Whatever is faulty or defective in the system of any army is soon detected, to its cost, when brought into collision with a better system. Still the national characteristics will be more or less preserved. Our neighbours the French, for instance, who like to reduce everything to system, enter into minutiæ which we should never think of. In a recent work of much merit by the Professor of Military Art at the Imperial Academy of St. Cyr, there are diagrams showing the several geometrical figures which a corporal's patrol should form, according as it is composed of from three to eight men.

But, though the first principles of outpost duty are universal, and can rarely be departed from with impunity, their application may be infinitely varied according to the nature of the country, the character of the enemy to whom you are opposed, and the constitution of your own force. Indeed I may say that they must be greatly modified by these considerations. This would be more especially the case when European troops find themselves engaged in warfare with half-savage nations; as, for instance, the French in Algeria, or we ourselves in New Zealand and Kaffraria. When opposed to disciplined armies of whatever nation, the safest rule is to treat your enemy, however unenterprising he may have hitherto shown himself, with due respect; for, as Marshal Bugeaud remarks, "one intelligent and energetic man may change the habits of an army." "An army counting

on the mistakes of the enemy," says Decker, "would itself commit the most fatal of mistakes."

A high authority on all matters connected with light infantry, the late Sir Harry Smith, related to me an instance of the heavy penalty incurred by a French division in the Peninsula through neglect of this rule. It had been for some time in face of a Spanish force, and had doubtless been in the habit of driving in their piquets with ease whenever it thought fit. At daybreak one morning on came the French, with their usual impetuosity; and, presuming on their former success, left their supports too far behind. But, unfortunately for them, the Spaniards had been relieved during the night by a British division, and the outposts had been taken up by the Rifle Brigade. The consequence was that they met with a very different reception, and were driven back with heavy loss.

Decker, in the work to which I have already alluded, attempts to classify the different nations of Europe in respect to their qualities as light troops. To the Germans he, as a Prussian, of course awards the palm. Indeed, in another part of his book, he goes so far as to assert that in Spain the Duke made use of his German troops only for outpost duty! The French he calls "confident," meaning of course over-confident; the Russians "dangerous," on account of their swarms of Cossacks; the Spaniards "lazy;" and, what concerns us most nearly, he calls the English "heavy," —*pesants*.

Now if we try, as far as possible, to divest ourselves of national prejudice, what will be our estimate of British soldiers as light troops? That they are less intelligent than French soldiers we must, I think, allow. The fact of the conscription embracing all ranks will go far to account for this; in proof of which we need only look to the superior aptitude of our Volunteers for learning their drill. I am speaking at this moment solely of intelligence.

Napier, in his History of the Peninsular War, asserts that the army lay down to rest with a feeling of greater security when the cavalry of the German Legion held the outposts, than when they were taken by our own light dragoons; and I suppose that there must have been some ground for this assertion. It should, however, be borne in mind that the Germans were old campaigners when they joined the British army in the Peninsula, whereas our own cavalry had never taken the field before. I may here remark that the care and the detail with which the duties of outposts are laid down in German military works seem to show not only the attention paid by them to this subject, but their national aptitude for warfare of this nature.

My own experience would lead me to think that the British soldier is not so watchful as the foreigner. I have not forgotten that during the first winter on the heights of Inkerman, when our outpost duty was the most harassing and the most critical, our poor fellows were sadly overworked and underfed, and that under such depressing influences watchfulness was doubly hard; yet even under more favourable circumstances there certainly was a want of vigilance which it required all the exertions of their officers to guard against. And this, I think, may in some measure be attributed to a constitutional indifference to danger. Certainly it is better than the opposite extreme of over-sensitiveness to danger, which

leads to so many false alarms, even if it does not entail more serious consequences.

Considering the indiscriminate nature of our recruiting, which brings into our ranks many men physically and morally unfit for the duties of light infantry, there is much to be said in favour of our former system of flank companies; but doubtless the disadvantages more than outweighed the advantages of this selection. All distinctions between regiments as well as between companies is also virtually done away with; for, though some few are still called light infantry, yet, armed and trained as they all are alike, there is no real difference, except that a long-established good system of training, and the prestige that attaches to the old Light Division, makes such regiments as the 43rd, 52nd, and Rifle Brigade hard to equal.

But, whatever drawbacks there may be to the present system, the numerical weakness of our army compared with those of other powers, and the consequent necessity of every part of it being prepared to act in any capacity, have left us no option, and we must make the best of the materials we have.

I may remark here, that in the French Army the distinction between heavy and light regiments of the line has been abolished within the last ten years; but, on the other hand, the number of the battalions of chasseurs has been augmented, and greater care than ever has been bestowed upon their composition, and upon their training, which, as all my military hearers are aware, is special, and calculated to develop to the utmost all those physical and mental qualities required for the efficient performance of the duties of light troops. The chasseurs are recruited in particular departments of France, especially, if I am not mistaken, in the mountainous district of Auvergne.

But, to return to our own service, there is a coolness in danger, for which the British soldier has been always conspicuous, which should go far to make him superior to all others for outpost duty; for it is when acting individually, or in small parties, that the qualities of self-possession and self-reliance become of highest value; and the more so when combined, as is the case with our soldiers, with physical superiority. It is only necessary to read the secret instructions of the Great Frederick, and some of Napoleon's letters to his brother Joseph, written just after the battle of Maida, to see that it is not in every army that coolness under fire can be reckoned upon, as, happily, it may be with us.

Those who have served with a French army in the field, must have perceived that they invariably attempt to make up for their inferiority in this respect by an increase of numbers. A detached post which we should hold with a subaltern's party, they would occupy with a whole company; and, in place of a chain of sentries along their front, they would sometimes, in exposed positions, plant a chain of small piquets.

Still, our neighbours, with their usual self-complacency, are perfectly satisfied of their vast superiority to us as light troops; in proof of which I need only adduce the following remark made by a French marshal to an English officer, since the Russian War: "Should it ever be my ill fortune," he said, "to be opposed to an English army, do not suppose that I should be so foolish as to attack them in their position; nor should I, perhaps,

await their attack in mine; but I would harass them out of their lives, and never allow them to close an eye."

On the principle of "fas est et ab hoste doceri," let us ask ourselves whether this be indeed our weak point, and, if it is, let us use every exertion to strengthen it.

Within the last few years, far more attention has been paid to this important subject than formerly; to which the introduction of the rifled musket has greatly contributed. It was felt that it was too costly and too perfect a weapon to be placed in unskilled hands, and that, if it was valuable when used by troops of position, it might be made tenfold more so when used by light troops thoroughly instructed in its use.

It is, I think, impossible to overrate the benefits that the army has derived from the establishment of the School of Musketry, not merely from the improvement in our rifle practice, important as that is; but from the increased zeal and intelligence of all, whether officers or men, who have passed through a course of training at Hythe—qualities which they, in their turn, impart to those who pass under their instruction. The faculty of judging distances correctly is, in itself, no slight advantage in light infantry movements, independent of the mere aim; and the increased confidence of the soldier in his weapon, resulting from his better acquaintance with its powers, must necessarily increase his confidence in his own means of resistance against any enemy to whom he may find himself opposed.

It is a question of the deepest interest, and one which at the present moment is occupying the thoughts of our most scientific officers—naval as well as military — how far the introduction of what the French call "armes de précision," will affect all operations of war; and, with your permission, I will offer a few remarks upon its bearing on that particular branch of which we are treating.

I have had the advantage of discussing this subject with General Hay and Colonel Wilford—two very high authorities—and it is the decided opinion of both, that the Enfield rifle is essentially a defensive weapon. A very cursory examination of the grounds on which this opinion has been formed will convince every one of its validity. It is obvious that the Enfield rifle is used with far greater effect by stationary troops than by troops in motion. It is in the hurry and excitement of a rapid advance—and in attacks upon outposts advances, to be successful, must be rapid—that rifled muskets are of least value. With a constantly and rapidly decreasing range, the sights are no longer of use, even were the men disposed to use them; whereas the piquet, which in most cases must have had time to ascertain, if not by actual measurement, at least by leisurely survey, the distance of every point at which an enemy can show himself, is prepared to welcome him with a concentrated fire.

Think how this advantage may be increased by an abattis, or any other obstacle, natural or artificial, which may have the effect of impeding, even for a few moments, the advance of the attacking force. Think too of the distance at which, in a moderately open country, the assailants must come under fire, and it will be evident how greatly the increased range will be in favour of the defending party.

On the other hand, it cannot be denied that henceforth it will be neces-

sary for outposts to take up more distant, and consequently more exposed, positions than has hitherto been usual, in order to prevent the camp or bivouac from being annoyed by the enemy's artillery—I may even add, by their riflemen. This will, as a necessary consequence, lead to an increase in the number of supports requisite to insure the safety of the advanced posts, in the event of their having to fall back upon the main body.

We may see from these considerations how expedient it is that all troops should be thoroughly trained to act as light infantry. With the formidable weapons now in use,—and who can say that they have yet reached their limit?—not only will more numerous outposts be needed, but increased rapidity of movement generally, and the power of advancing or retiring without disorder under fire in looser formation than the column or even than the line.

One certain effect of the long range will be that in future piquets will feel the necessity of protecting themselves by field works of one kind or another, whenever the nature of the ground affords them no cover. I should mention, however, that the French are of opinion that the habit of entrenching themselves makes the outposts timid, and therefore do not permit it except under special circumstances. Our own experience in the trenches goes far to confirm this opinion.

I must premise that the observations I am about to make on outpost duties apply solely to the employment of infantry. Having received my military education in the Rifle Brigade, that branch of the service has been of course my special study; and in the field I have had no experience of the employment of cavalry and artillery in those duties. Such an extension of my subject, did I even feel myself competent to it, would also make it difficult to compress it within the limits of a lecture.

In a level and more or less open country cavalry would evidently have decided advantages over infantry in the celerity of their movements, and in being able to observe the enemy at a greater distance, and would therefore be largely employed. But, beyond giving to the infantry outposts—for these would of course not be superseded by the cavalry piquets—some increase of security, it would not, I conceive, materially affect the dispositions that an officer in charge of outposts would make, inasmuch as, from the wide arc described by a chain of cavalry piquets, it would be impossible at all times to prevent even large bodies of troops from passing unperceived through their intervals. For instance, in the operations on the Coa in 1810, one regiment of German hussars covered a front of twenty-five miles, and was several miles in advance of the most advanced infantry outposts.

As regards the employment of cavalry, I will only add that, in all countries except such as are absolutely impracticable for cavalry—and our Chairman can tell us from personal experience, that even the most rugged parts of the Pyrenees were not impracticable—small bodies of horse, whenever available, are invariably attached to the infantry outposts for the purposes of communicating more rapidly with the main body, of furnishing patrols, and of occupying with vedettes points which are too distant to be prudently held with infantry. The manner in which they should

perform these most important duties will, I hope, form the subject of a future lecture in this place.

The employment of artillery presupposes operations on a larger scale than comes within the scope of this lecture, which will treat only of the handling of individual piquets; nor has it any direct bearing upon the subject, its value consisting in the support that guns afford to the piquets whether acting on the defensive or the offensive.

In its main features the system of outposts adopted in the English, French, and German armies is one and the same. In all there is, as a general rule, a triple cordon to protect the main body; first, the chain of sentries, which with us are always double (with the French and Austrians they are only doubled on posts which require more than ordinary vigilance); next, the line of piquets, properly so called, from which the sentries are furnished; and lastly, the supports. Where the outposts are covering a large body, and consequently are thrown far in advance, there would be besides these, a reserve, which would be furnished from the main body, and would occupy some strong position covering the camp. The supports will be posted at central points. Where several roads converge towards the camp the point of junction must be strongly held, in order that support may be sent in whatever direction it may be needed, and that the advanced posts may have a rallying point on which to fall back.

The nature of the ground may further require the detaching of small piquets of support to strengthen weak points of the line, or to keep up a communication between the piquets and their advanced sentries where the latter are concealed from view by inequalities of the ground. Of course service of this nature cannot be fettered by specific rules.

The comparative strength of the component parts of the outposts is determined by the necessity of having a sufficient number of reliefs to divide the duties, which become the more severe the nearer to the enemy. Thus the piquets must be of at least three times the number of the sentries they are called upon to furnish. The supports are only required to be of equal strength with the piquets, as under ordinary circumstances piquets are seldom relieved during their tour of duty, but, as the supports are required to send out frequent patrols, it is desirable that they should be of sufficient strength to enable them to perform this duty without weakening themselves too much.

Whenever possible the outposts should all belong to the same corps or brigade. It ensures greater unity of action; and the confidence that the men naturally feel in their comrades, and in their officers, is a source of strength.

I have already observed that, in the application of the rules laid down for outpost duties, an officer must be guided by the nature of the ground he is ordered to occupy. It is obvious that in an unenclosed and unwooded country a comparatively small number of piquets will suffice to cover all the approaches effectually; while in a country dotted with patches of wood, or otherwise intersected, it is almost impossible with any number to guard against a surprise. In such a case the only remedy is to send out frequent patrols.

In the combat of Maya the value of patrols under such circumstances

was strongly exemplified. A round hill in front of the British position masked the movements of the enemy in one direction. It was too distant to be occupied by night. In the morning a staff officer having patrolled round it, discovered enough to make him order up the light companies in support of the nearest piquet, which was in a very exposed position. They had only just time to form on a neck of land, a short distance in rear, when a French division appeared on the summit of the hill, followed by a second. The piquet was forced back with great loss upon the light companies, who with difficulty sustained the shock until reinforced. Upon this Napier makes the following observations: "The Portuguese cavalry patrols, if any went out, which is uncertain, might have neglected their duty, and doubtless the front should have been scoured in a more military manner; but the infantry piquets and the light companies so happily ordered up were ready, and no man wondered to see the French columns crown the great hill in front of the pass."

Perhaps one of the surest tests of a good light infantry officer is to be able to cover his front thoroughly with as small a number of men as possible. A good disposition of your outposts will more than compensate for a deficiency of numbers. The first impulse of an inexperienced officer is to occupy every commanding position, which is quite unnecessary even had you the men to spare. Even an experienced officer will generally find on revisiting his advanced posts that he can make a more judicious and a more economical distribution of his force.

One of the best proofs that the distribution is really judicious will be the fact of his own posts being hidden from the view of the enemy, while themselves overlooking the whole country round. Yet, desirable as this concealment is, he must not sacrifice to it the advantage of gaining an extended look-out.

In many, I might perhaps say in most, cases the features of the country will mark out the natural cordon of the outposts. There will be either the course of a stream or a line of road, or a ridge of heights to determine this point for you. But in a country abounding in small hills it is difficult to know where to stop with your piquets and sentries. There will always be some eminence just beyond your actual position which it would be desirable to occupy. Here great judgment is required, for the advantage to be gained may be more than balanced by the disadvantage of a too great extension and consequent weakening of your line. Yet this latter alternative must sometimes be preferred, for it is better to risk the loss of a post than to compromise the safety of the army. An instance in point may be found in the battle of Albuera, where Napier attributes the imminent danger of the Allies to the neglect to occupy with a piquet a hill, behind which the French were in consequence enabled to make their disposition for the attack unperceived.

This is a question which, like many others in this most responsible service, must be left to the judgment of the officer in command. It may, however, be laid down as a fundamental rule that wherever possible the outposts must feel those of the enemy. To ascertain his exact position is one of the chief objects for which they are posted. The increased rapidity of the movements of troops in modern warfare renders this task at once the more necessary and the more difficult of execution. Under

any circumstances the outposts must be sufficiently distant to give the main body ample time to get under arms.

A happy mixture of caution and boldness will in most cases be successful, it will inspire your men with greater confidence than more timid measures. Danton's celebrated saying, "De l'audace! de l'audace! et toujours de l'audace!" may in some cases be well applied to the conduct of outposts, provided of course that daring does not become foolhardiness. If the line of retreat of an advanced piquet has been carefully studied, it will generally be able to fall back with safety in the daytime even before a greatly superior force. At night there is probably less risk of its being cut off, for it has the advantage of a better acquaintance with the ground, and in a night attack the movements of the assailing force are rendered hesitating by the fear of falling into some unseen danger. If in immediate contact with an active enemy, the security of a piquet at night may be greatly increased by changing its position from time to time, even if it be only by moving it a few yards to the right or left. It is almost unnecessary to say that, under such circumstances, the night post of a piquet must always be taken up after dark, and that the ordinary precautions of preserving silence and having no fires must be strictly observed. The sentries will, as a matter of course, be withdrawn from the heights into lower ground, in order that they may better discern the outline of an advancing body against the sky.

In most works on outpost duty it is laid down as a rule that the chain of piquets should be drawn closer by night. Marshal Bugeaud, on the contrary, insists, and with some show of reason, that it should be extended. "In the daytime," he says, "it is the eye that guards," whereas at night the enemy's approach can only be known by actual contact, and therefore he must be felt for at a greater distance in order to guard against surprise.

Still it would hardly be advisable to extend your chain of outposts by night, or even to occupy as much ground as by day, for the necessity of planting your sentries closer to each other would entail a considerable reinforcement of the piquets. As, however, in a night attack the enemy would scarcely venture to quit the roads for fear of missing his way, it might be expedient to station advanced piquets on the principal approaches, not posting them across the road, but on either side. In a work on outposts, published a few years since in Austria, it is suggested that on a dark night withered branches should be thrown upon the road some forty or fifty paces in front of the post, that the approach of any party might be betrayed by the rustling of the leaves. In the same book mention is made of small posts called *schnarr-posten*, which I never heard of before. The literal translation is rattle-posts, and their duty is simply that of watchmen. They are thrown out on dark nights in front of all piquets, whether infantry or cavalry, to listen for the approach of an enemy. In the latter case they are dismounted and stationed at some distance from the piquet, that the noise of the horses may not interfere with their hearing. But, after all, the security of a position will be equally attained, and with less risk, by sending out frequent patrols, especially towards break of day.

Night attacks are seldom resorted to in these days. Even when the

preconcerted instructions have been fully carried out, which rarely happens, the confusion and uncertainty inseparable from such attacks seldom allow of any decided advantage being gained. Our own experience in the Crimea shows how easy it is to miss your way at night even on ground with which you are thoroughly acquainted.

In a little work of Marshal Bugeaud, an anecdote is related which bears upon this point: An officer received orders one evening to occupy a certain position—a somewhat exposed one, no doubt; he ventured to remonstrate, saying that his piquet would certainly be cut off before morning. The general then ordered him to take a party after dark and carry off an advanced post of the enemy, the position of which he pretty well knew. He now began to speak of the difficulty of finding by night exactly where the post lay; upon which the general remarked that probably the enemy would experience the same difficulty in finding his post, and directed him to obey his first order. The Marshal then adds, as the result of a long experience, that if these duties are performed with common intelligence the piquets will run no risk, and the army will camp in security. An officer in command of a reserve, or of a support, having several piquets in advance of it, may find it useful to adopt a plan which we tried in the Crimea. At night he will sometimes find it difficult to know from which of the piquets a shot is fired, especially if he is not familiar with the ground. But by placing sticks or heaps of stones in front of his support, pointing in the direction of each of the several advanced posts, he will find them of great assistance in determining from what point the firing proceeds.

Attacks are usually made at daybreak, all the preliminary dispositions having been made under cover of night. For this reason troops, when near the enemy, are always under arms an hour before dawn, and remain so until intelligence is received from the front that all is quiet; for the same reason the relief of the outposts usually takes place at this hour, in order that they may be in double strength to repel any sudden attack. The old piquets are not withdrawn until there is sufficient light to discern objects at a considerable distance. The soldier's well-known criterion of daylight is when you can see a white horse a mile off!

It was a frequent practice with Napoleon to make a threatening movement with his outposts at dusk, in order to throw the enemy on the defensive, and disconcert any offensive movement that he might have been planning.

If a piquet, in retiring before a superior force, finds itself hard pressed, it is sometimes advisable to diverge a little from the direct line of retreat, especially if by so doing you can draw the enemy into more broken ground. In both the French and Prussian services this diagonal line of retreat is enjoined as the rule. By so doing you also leave the front of your support clear, and expose the enemy to a flank fire. Care must, however, be taken not to lose sight of the advancing force, as this might compromise the safety of your support. It may also be advantageous to retire in two divisions, which can afford each other a mutual support.

It will depend upon circumstances whether, in the event of the piquets being attacked, they should fall back upon the supports, or the supports advance to their assistance. The latter is somewhat dangerous, unless a

corresponding advance be made by the reserve, if there be one, or reinforcements be at once sent forward from the main body to take their place. If, however, the piquets be hard pressed, and it be important to maintain the position, the supports must advance without hesitation, sending immediate notice to the rear. Under no circumstances must the supports fall back until they have rallied to them all the advanced piquets. Outposts, even when seriously threatened, must not lightly relinquish their ground; by showing a bold front they may often force the enemy to discover his force and even to develop his intentions. All waste of ammunition by unnecessary or too rapid firing must be carefully checked. The temptation to the latter fault will be greatly increased if ever it should be decided to arm our infantry with breech-loaders. The former is still more objectionable, for, besides throwing away ammunition, which it is always difficult, and sometimes impossible, to replace, it has the effect of needlessly alarming and harassing the troops, to whom when on active service every hour of repose is of incalculable value. It is only in actual self-defence, or when the intended advance of the enemy is beyond a doubt, that the sentries should ever fire. If they have only reason to suspect that an attack is meditated, it is better to send a man to the rear to warn the supports, without obliging the main body to stand to their arms.

There is, perhaps, no campaign on record of equal duration, and on so large a scale, which was so uninstructive in all that relates to outpost duties as the late war with Russia. Lallemand in his excellent treatise on the minor operations of war, defines the object of outposts as twofold: "The safety of the corps that establishes them, and the observation of the enemy's troops." Now in the Crimea the nature of the ground, and other causes, restricted us entirely to the former of these duties. In the Second Division we had, during the first few months of the siege, heavy and harassing piquet duties, but their sole object was to guard our own position, as far as possible, against a surprise; and night after night the same posts were necessarily occupied to cover the approaches to our camp. The bulk of the Russian army lay on the heights beyond the Tchernaya, at a distance of more than two miles, and in a position so unassailable that they needed no outposts and probably had none.

Nor has the most recent European war been more instructive in this respect, though from the introduction of improved firearms we might have expected some valuable experience. In the first place, the rich plains of Lombardy are so highly cultivated, and covered with such luxuriant vegetation, that military operations were almost confined to the high roads, at least during the earlier part of the campaign. And in the second place, if I may presume to say so, the outpost duty of both armies appears to have been conducted with so much carelessness that we have nothing to learn from it. It is, I believe, an undoubted fact that on the eve of the battle of Solferino, the two armies were, at some points at least, not more than five miles apart, and yet remained in utter ignorance of each other's approach until they came into actual collision.

In studying, therefore, the second and most interesting portion of the duties of outposts, or rather the combination of the two, we must look to the annals of former campaigns for our instruction, and nowhere can we

find it more readily or more fully than in the history of the Peninsular War—a war carried on between two of the best trained armies of Europe, and on a scale which enables us to follow and criticise the movements, not merely of large bodies of troops, but of brigades, single regiments, and even detached companies, thus affording practical instruction to officers of every rank. That war possesses, moreover, this additional advantage, that the one side consisted of troops of our own nation, which will make it a surer guide for any future operations in which we ourselves may be called upon to take part.

Perhaps the best study for light infantry movements in the field will be found in General Craufurd's celebrated operations on the Coa in 1810, and in the campaigns of 1812–13 in the Pyrenees. The first of these will teach us how these movements should be conducted in a comparatively level and open country; the second will give us valuable lessons in mountain warfare, and in the guard of passes and defiles.

It is laid down by all military writers, as the leading principle of outpost duties, that all engagements with the enemy must be avoided whenever possible, unless, indeed, the safety of the main body should imperatively demand the maintenance of a post at all hazards. This is implied in the name of secondary operations of war applied to these duties. Numerous instances are recorded of partial and even general actions having been brought on, and the best laid plans of the general defeated, by unnecessary and ill-judged engagements between the outposts. It seldom happens, or rather it should seldom happen, that outposts are forced into an engagement. It usually implies a want of vigilance or of prudence.

Now Craufurd, though a great soldier—and the value, even at the present day, of his standing orders for the Light Division proves that he was a great soldier—was in the constant habit of contravening this principle. He seemed to delight in provoking an attack, from the consequences of which he was on more than one occasion saved only by the excellence and gallantry of his troops. The force under his command was indeed composed of the finest materials. It consisted of Sir Hew Ross's troop of horse artillery, the well-known chestnut troop, the finest probably in the world; a regiment of hussars of the German Legion, excellent light cavalry; the 43rd, 52nd, and 95th, long and carefully disciplined by Sir John Moore; and two battalions of Portuguese caçadores, officered by Englishmen, and under such guidance admirably adapted to a service of this nature.

Such was their training, that, in the words of Napier, "seven minutes sufficed to get under arms in the night; a quarter of an hour, night or day, to gather them in order of battle at the alarm posts, with baggage loaded and assembled at a convenient distance in the rear; and this not upon a concerted signal, and as a trial, but all times certain, and for many months consecutively."

"Strong advanced guards," says Decker, "are exposed to the temptation of engaging the enemy unnecessarily." What wonder, then, that with such a force under his command—a little army in itself—this temptation should have been too strong for a man of Craufurd's fiery temperament, and that in his thirst for distinction he should at times have forgotten that the safety of the army was confided to his keeping!

In the Historical Record of the 52nd, recently published, the following characteristic conversation between the Duke and Craufurd is recorded. On the latter rejoining the army after one of these hairbreadth escapes, Lord Wellington asked him, "Why, Craufurd! where have you been? I thought you were lost." "No, my lord," said Craufurd, "I was quite safe." "Ah!" replied the chief, "that was all very well for you, but, by Jove! I was not."

Decker well remarks on this subject, that "the fact of an enemy not venturing to attack the outposts ought to be a sufficient reward for all the fatigues incurred in this harassing duty."

If I had allowed myself to make extracts from the many works that have been written on these operations by officers who bore a part in them, —such men, for instance, as our present Chaplain General, or my first captain, so well known as "Johnny Kincaid, of the Rifle Brigade,"—I might have made my lecture far more interesting to a mixed audience, or indeed to any audience; but I did not feel myself justified in doing so, unless the incidents recorded bore upon some principle of outpost duty. There is, however, scarcely a page that does not convey some useful hint, either as to what should be done, or what should be avoided; for even with such troops as the Light Division mistakes are at times inevitable.

At the combat of the Coa, for instance, where the division was hard pressed by an overwhelming force, which threatened to intercept its only line of retreat, the 43rd were incautiously thrown into an enclosure of masonry ten feet high, and having but one narrow outlet. Fortunately the masonry was not very solid, and by an united effort of the whole regiment a part of the wall was thrown down, just in time to save them from being cut off.

Now there is, perhaps, not much fear of an officer of ordinary intelligence compromising his detachment to such an extent as this, it being one of the first rules laid down in the Book of Field Exercise that a piquet must not shut itself up without orders; yet sometimes he might be tempted, by the apparent strength of a position, to occupy it, without sufficiently considering whether his line of retreat might not be endangered by obstacles of one kind or another immediately in his rear,—a long high wall, for instance, or even a hedge. I need scarcely remark that broken ground may sometimes be more favourable to the attacking than to the defending force, especially if it extends along a portion only of the front, and thereby renders that portion liable, by the delay it occasions, to have its flank turned. Perhaps some of my hearers may remember that at the battle of Nivelle the French lost several hundred men by throwing them into one of the fieldworks by which they had thought to strengthen their position. The Light Division drove back the troops on either side, and the detachment, completely cut off, surrendered to the 52nd Regiment. There is therefore no rule more necessary to be borne in mind than that of always keeping your line of retreat open; and, with this view, every officer in command of a piquet should carefully study the ground between him and his supports, settling beforehand in his own mind the spots on which a stand could be made, in the event of his being forced to fall back. This, as our drill-book points out, should be done during the march of the piquet to take up its position; for, if in close contact with the enemy, it

would of course be impossible for him afterwards to quit his post for this purpose. To seize at a rapid glance the leading features of a position requires experience, and young officers will find it a useful practice in their rides or walks through a new country to look upon every accident of ground with a soldier's eye.

But it is not solely with a view to ensuring the safe retreat of his own piquet that an officer should study the country around his post. Such knowledge may prove of the greatest use in determining the movements of the army whose advanced guard he may at any moment become. For this reason he should endeavour, by every means in his power—by personal examination, where possible, or by the report of his patrols, or by information gained from the inhabitants—to ascertain such matters as are most essential in a military point of view, such as the direction and state of the roads, the course and depth and bottom of any rivers or streams, the proximity of any defile or swamp, or other natural obstacle. In a word, the outposts should be the eyes of the army.

The officer who has the general superintendence of the piquets will, of course, give such instructions to each officer as he may think needful; and will acquaint him with any special object for his having been posted at that particular spot; but, under all circumstances, much must be left to his own zeal and judgment—still more to his sleepless and untiring vigilance. He must ever bear in mind, that one hour's remissness may render useless weeks of anxious watching, and, which is infinitely worse, may compromise the safety of the army, and defeat the most skilful combinations of the general.

It stands to reason that a piquet is at all times liable to be attacked by a greatly superior force; and this liability can only be met by an unremitting watchfulness. On this point the Great Frederick gives a piece of advice which will be valuable to all officers in command of outposts. He recommends, that they should take pains to convince their men of the necessity of that vigilance which they enforce; and he adds, as the result of a long experience in the field, that "the sleepers and the negligent are beaten by the wakeful and prudent."

For a piquet to be surprised is, of course, a disgrace to its officers.

If very near an enemy, the chain of sentries must be posted nearer to each other, especially by night, and one man of each file must patrol without intermission up to the adjoining post, while the other stands to his front, and keeps a sharp look-out. Under such circumstances the officer must be all eyes and ears, both for the security of his own piquet and for the general good. He will watch with suspicion the slightest symptoms of a movement within the enemy's lines, such as a cloud of dust in the daytime, a brighter or fainter blaze of the watch-fires by night, or the rumbling sound of guns in motion, or the neighing of horses. Signs trifling in themselves may serve to confirm or refute the reports of scouts and deserters, and therefore they should at once be transmitted to the rear, and, where possible, in writing, for fear of mistakes. Notice must also be sent to the adjoining piquets of any anticipated movement on the part of the enemy.

A laughable instance of over-suspicion occurred in the Second Division on the heights of Inkerman, during the winter of 1854–55. After dark

word was sent up from one of the advanced posts, that suspicious sounds were heard rising from the valley below, like the rumbling of wheels. An officer was sent forward to reconnoitre, and on reaching the edge of the valley he found, to his amusement, that they proceeded from myriads of frogs on the marshy banks of the Tchernaya.

However well the front may be covered by sentries, the piquets must still watch. A portion, smaller by day and larger by night, must always be ready. When a fire is permitted, one half only of the piquet should be allowed to sit round it at one time, while the other half keeps itself a short distance apart, and on one side, so as to take in flank any party that may suddenly fall upon them. The alarm-post must be fixed in rear of the fire, so as to give the piquet the double advantage of being itself in the dark and forcing the enemy to expose himself to the light. Piquet fires should be made, where practicable, in hollows, so as to be as much as possible hidden from the enemy. Sods or damp earth should be kept close at hand to extinguish them in a moment. It may sometimes tend to mislead the enemy as regards the site of the piquets, if fires are lighted at other points of the position.

One of the first duties of an officer on piquet is to place himself in communication with the piquets on his right and left, not merely with a view to forming a continuous chain and preventing bodies of the enemy from passing through, but also for the purpose of concerting a combined plan of operations in the event of having to retire. He should look upon his piquet as a link only of that chain—as it were a file in a line of skirmishers—and should conform his movements accordingly. However strong his own post may be, it is obvious that it is worse than useless to attempt to maintain it if the piquets on either side have been driven back and have left his flank exposed.

I may here remark that it is not usually by skirmishers that a position is carried. Columns of more or less depth, or single companies with closed files, break through the weakest points of the enemy's line, compromising the safety of the remainder, and forcing them to fall back in haste. This was pointed out very forcibly by Sir John Burgoyne in his remarks on the defence of the country against invasion, at a time when it was argued by writers in newspapers that skirmishers occupying our hedgerows could arrest the advance of an invading army. On the same principle the attack of a superior force will in most cases be more effectually checked by concentrating your piquet on the key of the position and receiving them with a close fire or with the bayonet. A striking instance of this occurred at the combat of Roncesvalles. It was of vital importance to secure the pass of Atalosti, but the French were nearer to the summit than the English. General Ross, however, who had preceded his brigade, had one company of the 20th Regiment in hand. Instead of attempting to check the advance of the French by the fire of skirmishers, he called upon them to charge the front of a French light infantry regiment which headed the column. They did so without hesitation, and, though eventually driven back by overwhelming numbers, the object was gained, Ross's Brigade reached the summit, and the pass was secured. An offensive movement may, with advanced posts as with armies, sometimes prove the best defensive.

When a piquet forms one extremity of the chain of outposts, the officer will, if possible, rest his outer flank on some strong point, taking care well to overlap the front of the main body. Should none offer, it will be advisable to refuse that flank, and further to detach a support towards it as a point of appui.

Every road which leads towards the camp must be carefully guarded. If there are more than can be occupied by the force at his disposal, the officer in command should close some of them by temporary obstructions. On no account, however, must he break up a road, without express permission, lest it should interfere with a meditated advance of the army. Still less must a bridge be destroyed without orders, though it may be rendered impassable for a time by the removal of a beam, or in some other way that admits of easy repair. With these exceptions it is not only allowable but incumbent upon an officer to strengthen his post by every means within his power—such as felling trees, constructing abattis, or throwing up rude entrenchments. With the improved musket these precautions, as I have already observed, become doubly needful. If the ground he occupies afford absolutely no shelter, it will be well to construct, for the sentries at least, the simplest form of rifle pit, such as were used by both sides before Sebastopol.

I need scarcely point out that in some cases it may be as necessary for the safety of a piquet to pull down walls and fill up ditches, as it is in others to build and to dig them.

The mode in which natural obstacles may best be turned to account and artificial ones created may be studied with advantage in Jebb's "Practical Treatise on Strengthening and Defending Outposts." I need only cite the defence of Hougomont as a proof of the readiness with which, by a few ingenious and at the same time simple expedients, a dwelling-house may be converted into an impregnable fortress.

Another important rule to be observed is that outposts and their supports should be placed on the same side of any difficult passage—such as a stream, a swamp, or a defile,—and, if possible, behind it. This rule cannot of course always be adhered to, for, at whatever risk, the movements of the enemy, or at least his actual position, must be discovered. For example: if you are covering the line of a river—I am here speaking of a small river which is either fordable or can quickly be bridged over—and the opposite bank is the higher, or of a nature to afford cover to troops, it will be necessary, whenever possible, to keep small posts beyond the river to prevent the enemy from assembling in force and falling upon you unawares. This course Craufurd pursued with success when covering the line of Azava, though at the imminent risk of having those posts cut off.

On the other hand, the neglect of this precaution led to the defeat of the French army near the Bidassoa, under the following circumstances: Its left flank rested upon that river, and when the piquets were posted the stream was found to be impassable; consequently it was deemed unnecessary to send even a patrol across to feel for the enemy. Now the opposite bank was covered with tall crops of maize, and the Allies took advantage of this to place a large force unperceived close by the water's edge. At low water—for the Bidassoa at that point is a tidal river—they suddenly

forded the stream, and falling unexpectedly upon the French, drove them back in confusion upon Urugna. Now had patrols been sent across the river as soon as the tide permitted, this defeat might have been prevented.

This example should teach us that no precaution can be neglected with impunity. A commander gifted with foresight will be prepared for any contingency however remote. To quote again from Marshal Bugeaud: "It is enough that an enterprise be possible, for a prudent soldier to take every measure to guard against it." Probably it did not occur to the French commander that the Bidassoa was affected by the tides; but rivers, whether tidal or not, require to be carefully watched, for in mountainous countries especially they are liable to sudden rises and falls, either of which may compromise the safety of an army. Napier mentions that the Agueda sometimes rose several feet during the night without any apparent cause.

And now let me give an example, drawn from our own records, of the advantage resulting from forethought in such matters. Shortly after the action at Sabugal one company of the 52nd and half a company of the 95th were posted on piquet at the bridge of Marialva on the Azava. A second company of the 52nd was stationed at a ford not far distant; the French in greatly superior force attacked the Marialva piquet and pressed it hard. Captain Dobbs, who commanded the other piquet, seeing that a good deal of rain had fallen during the past night, suspected that the ford which he had been set to watch was no longer fordable. Having ascertained this to be the case, he took upon himself to leave his post in charge of a corporal and file of men, and hastening with the rest of his company to the bridge, arrived just in time to save his comrades from being overpowered.

In warfare of this nature no advantage however trifling in appearance should be despised. Napier relates that at Barba del Puerco, on the Agueda, the French commander, wishing to drive in our piquets, collected his column after dark at the head of the bridge, and, waiting till the moon, rising behind him, cast long shadows from the overhanging rocks and deepened the darkness of the ravine, crossed at the double, bayoneted the sentries, and succeeded for a while in driving in our outposts.

Even artifices may sometimes be advantageously resorted to, to impose upon the enemy. Craufurd wishing to conceal the weakness of his numbers—he was keeping the field at that time with a weak division within two hours' march of 60,000 men!—disposed his troops in single ranks on the rising ground, while he used some horsemen to raise a cloud of dust in the rear as if reinforcements were ariving. In the same way it may be well in some cases to show your piquets and supports, though the general rule, as I have said, is to keep them out of sight. In making their retreat the French used sometimes to plant "dummies" round the abandoned watch-fires with shakos on their heads and poles placed besides them to pass for muskets.

In short, outpost duty presents a wide field for the exercise of those qualities most valuable in a soldier: forethought, presence of mind, and fertility of resources. Decker—I quote from the French translation, which has the advantage of the comments of a soldier of another nation—Decker says: "Enfin l'art de savoir se suffire à soi-même peut être regardé

comme l'âme de la petite guerre." Even in the most desperate cases it is wonderful what may be done by troops imbued with this spirit of self-reliance. In the action of the Coa a half-company of the 52nd found itself completely cut off by the rapid advance of the French. Nothing daunted, it lay concealed till nightfall, and threading its way under cover of the darkness through all the enemy's outposts, succeeded in rejoining its corps on the following day without the loss of a man.

Another invariable rule in outpost duty is to avoid as far as possible placing your piquets—or even your sentries—within musket-shot of a wood or any other cover, especially if your own position affords little shelter. Rather than run such a risk the posts should be drawn closer to the main body. This would appear so obvious a rule as scarcely to need being laid down; but those who have read the accounts of the civil war in America will remember how utterly—and how fatally—it was disregarded at Edwards's Ferry or Ball's Bluff. How any man calling himself a soldier could draw up his force in an open field surrounded on three sides by a wood, and an unfordable river in its rear, passes all comprehension! It is an additional proof of the necessity of teaching even the simplest and most self-evident rules of war.

I have already said that no piquet is to shut itself up in a house without orders, unless indeed this offer the only chance of escape. Let me now add that it is not prudent, when near an enemy, to allow your piquet to occupy buildings even with easy egress, as it gives the men too great a feeling of security, and tempts them to relax their vigilance. Where the inclemency of the weather renders shelter necessary, the largest building and nearest to the line of sentries must be selected for occupation, and the unavoidable risk guarded against as far as may be by increased watchfulness.

But where a building commands the position to be defended—whether it be a bridge, or a defile, or an important road—then it must, of course, be occupied, and loopholed and otherwise strengthened for defence, care being taken to leave or to make sufficient outlets for the retreat of the little garrison. In the campaign of 1813 in the Pyrenees several instances are recorded of the successful defence of bridges by single companies against greatly superior numbers by a judicious occupation of the adjacent houses.

The late Sir William Reid, of the Engineers, who was attached to the Light Division during the campaign, bears testimony to the value of the skilful strengthening of his post by an officer on piquet. "It deserves to be recorded," he says, "that the outposts of the 52nd had been so well fortified by a captain of that regiment, that the piquets had no occasion to retire until they had expended their sixty rounds. This officer had taught himself how to strengthen posts by barricades and other temporary expedients, and he deserved the support he always received from the Engineers, who supplied him with what he required from their small depôt of entrenching tools. The piquets being thus enabled to hold their ground without risk for a considerable time, the troops for the defence of the position had full time to assemble (for it was December, and they were scattered in houses), and to deploy on the position. . . . . There was nothing," he adds, "in the defences which impeded the usual formation, and everything was prepared to maintain the ground offensively."

This last paragraph is high praise, for it shows with what skill and judgment the post had been strengthened. I have made this somewhat long extract because the passage struck me as being singularly instructive and encouraging to young officers, for whom, from the opportunities of individual distinction that it holds out, this service ought to possess peculiar attractions.

In the discharge of outpost duties, happily for the cause of humanity, certain rules are recognised by all civilised nations which greatly mitigate the horrors of war, and give to this branch of warfare quite a chivalrous character. The absence of this generous spirit in the hostilities now carried on in America gives them a peculiarly painful aspect in the eyes of military men; but it is in the very nature of civil war, embittered by personal enmities and conducted by undisciplined levies, that a feeling of mutual exasperation should arise, happily unknown to those whose only motives for fighting are duty and honour.

In the Peninsular War, where these mutual courtesies were carried to a greater height than ever before, it was an understood thing that the outposts of an army were not to be attacked except with the ulterior view of surprising the corps which they covered, as, for instance, in Sir Rowland Hill's surprise of Gerard at Arroyo de Molinos. This mode of warfare was not, however, quite intelligible or satisfactory to some of the members of the sister service. When the well-known "Charlie Napier" came from his ship in the Tagus to the lines of Torres Vedras to visit his still better-known namesake in the Light Division, he saw a French sentry quietly pacing up and down at a couple of hundred yards from the British lines. "Who is that fellow?" he asked of his companion. "A French sentry," was the reply. "A Frenchman!" exclaimed the sailor in amazement, "why don't you shoot him?"

Doubtless all my military hearers will remember that the "entente cordiale" between the British and French piquets led, at length, to an order from the Duke peremptorily forbidding all friendly intercourse for the future. And, indeed, it was high time, when the field officer on duty on going his rounds found the posts deserted, and the piquets of both sides carousing together.

The limits wisely imposed upon a lecture by the rules of this Institution have obliged me to omit many of the minor duties of outposts, and to pass lightly over others of more importance. The subject of patrols I must leave entirely untouched. Time only permits me to call attention, as briefly as possible, to the duty of commanding officers to instruct those under their command in this important branch of their professional education, and to point out in what manner this may best be done.

I am well aware that in our service comparatively few facilities exist for this instruction. The detached duties of our army often debar a regiment, for years together, from the advantage of taking part in field movements on a larger scale than those of a battalion, while the enclosed nature of the country around most of the stations occupied by our troops at home renders the light infantry drill even of a battalion a matter of difficulty. In a barrack-yard the practice of light infantry movements is most unsatisfactory; that of outpost duties is simply impossible. Yet, in the ordinary course of service, every regiment must, from time to time,

find itself at some station where these duties can be put in practice—especially since the formation of our camps of instruction—and, even under the most adverse circumstances, much may be done where the commanding officer really knows his work, and feels an interest in it. In the most strictly enclosed countries the highways and byeways will still afford him the means of teaching the military occupation of a country, and from some commanding position he will be able, at least, to point out to the piquets the line on which their chain of sentries should be posted.

Something may also be taught of theory. If a commanding officer would from time to time read over with his officers some work on military science, or some well-written narrative of a campaign, following the movements of the armies on the map, explaining, and inviting discussion, he would, I am sure, find the study both profitable and interesting—to himself as well as to the majority of his officers. It would be too much to say that he would be able to interest all, however well he might perform his task; but, without being too severe, I think we may say that the soldier who can feel no interest in the pages of such a work as Napier's has mistaken his profession.

If we look into the early history of our greatest soldiers—Wolfe, Moore, Wellesley, Colborne, and others whom I could name—we shall invariably find that before they rose into eminence, before they were called upon to take part in active service, they were remarkable for their attention to their regimental duties, and for their earnest study of their profession. Who can say how soon our fitness for our work may not be brought to the test of practice? Let their example be both an incitement and an encouragement to us to improve our present leisure; and let us take for our rule the maxim of the Great Frederick, that "it is the duty of every good officer to know war before making it, and then to apply himself to put his science into practice."

NOTE.—To those who wish to study this most interesting branch of their profession, I would recommend the following elementary works:—

Lallemand's "Operations Secondaires," which has been translated into English by Colonel Sir Thomas Troubridge, Bart., C.B.

Decker's "La Petite Guerre," which has been translated into French and English.

La Barre Duparcq's "Eléments d'Art Militaire."

And Captain Hauer's "Feld Instruktion," published at Olmütz in 1852, and to be found in the Library of the Royal United Service Institution. Besides these, there will be found in the index at the end of the Catalogue of H.R.H. the Prince Consort's Military Library at Aldershott, the names of numerous excellent works on this subject by writers of all nations, some of them of very recent date. But the most useful, and certainly the most interesting, course of study will be, after learning the first principles of outpost duty in some of these elementary works, to read carefully the history of such campaigns as best illustrate this mode of warfare, example being always more instructive than precept.

Sir EDWARD CUST said :—

In rising to propose the thanks of the audience to Colonel Wilbraham, I regret that he has not included the outpost duties of cavalry. The duties of the two services are so distinct, that almost all that has been said on the subject of infantry outposts would, to a light cavalryman's ear, appear to be that of in-posts. The duties of cavalry outposts are carried so far forward that I have been myself employed one hundred miles in advance of the British army on outpost duty. It so happened that I had the good fortune to sight the whole corps d'armée of Soult in their retreat from Cadiz, from an eminence on the Sierra Morena, when the British army were in quarters about Madrid. Outposts to an army have been likened to the senses of the living body. They are eyes, seeing far ahead into the darkest obscurity of the distant foe. They are ears, for not only do they hear the tramp of advancing troops, but they learn their number, their objects and intentions, their proportions, and the quality of their composing arms. They are the touch also, for they sensitively stand to avert the sudden and confusing shock of war, affording time and space for discipline and organisation; and for the other senses we may say, in the magnificent language of Job, "He *smelleth* the battle afar off, the thunder of the captains, and the shouting." It has been justly stated by Colonel Wilbraham, that the study of outposts is too much neglected amongst ourselves, and that the German cavalry showed themselves superior in these duties to the British, and were so considered by Wellington. There is, however, a little error as to the extent of this remark The German hussars, when they arrived in the Peninsula, were already old campaigners, whereas the British cavalry had scarcely smelt powder for fifteen years. The Germans were experienced hands, but they did not in fact form part of the Light Division, but they were always brigaded with a British regiment, and in this manner I have often also myself formed part of the Light Division. The Germans were, indeed, originally selected on a better principle to render them as a separate corps efficient upon outpost or any other intelligent duties.

The conscripts in Germany were never allotted to the hussar regiments in former days upon the principle that Saul was made a king because he was higher than his fellows, as we generally choose our light dragoons; but men of a superior social condition and education, though they were as small in stature as King David, were chosen for the purpose of hussars. Where men are obliged to act so independently of one another, as a light cavalry man must do, he should have some natural genius for war and all his wits about him. The Germans have, however, a merit that our men could never attain to: they regarded their horses as part of themselves. If they were ordered on a duty at two in the morning, they were stirring an hour previous, giving their *better halves* provender, and getting themselves a cup of coffee; whereas our fellows snoozed to the last moment, and, when roused for the "turn-out," just kicked up their horses, and got upon their backs,—the consequence of which was, that in a couple of hours both men and horses were knocked up, while the German hussar was good to the *mittagessen*.

The study of outposts belongs to every soldier, and I am sorry that there are so few young officers present, for it is not only that the light

infantry system should be learned, or the outpost duty explained to officers of each particular arm, but the staff officers would do well to inform themselves on this subject. I know not whether they form part of the instruction of the Staff College, but they should do so. A matter occurred in my own history in which I might have been seriously compromised by the ignorance of a staff officer. At the river Alva, in Portugal, after Massena had during the whole day checked upon its banks the advances of Wellington's army, he destroyed the Pont d'Alva, and pursued his retreat. This river was an exceedingly violent stream, having a bottom of pebbles as big as boulder stones, and our guide was frequently nearly drowned, or fell up to his armpits, and our horses also were in great danger at every step, in crossing the ford. A staff officer took a piquet of the 16th Light Dragoons, of which I was in command, across this impassable barrier, and posted us on a height above the river, with no other instruction than a "Good night," and then took his departure with his guide. I, of course, immediately went forward with a patrol, and took some prisoners and deserters, who might have afforded useful information; but I had no possible means of passing them across the river to carry back information to the officer in command of the advance, nor of getting away myself, if a hostile patrol had come against me.

The necessity of a superior class of individual soldiers for cavalry outpost duty was singularly exemplified in another event of my own history. When Wellington was about to cross the French frontier in 1813, he issued strict injunctions that the greatest vigilance and circumspection should be exercised by the piquets and patrols. Having become an experienced outpost officer after three years' unremitting work, I was charged with one of the first patrols that entered the French territory. I accordingly left the lines with about twenty-four men, all having their swords drawn excepting the advance and flanking dragoons on either hand, who rode with loaded carbines. After pursuing the high road for a mile or two, a considerable village took my attention, and I left the advanced dragoons in vedette, with the most peremptory orders for caution, and descended to the place, where I neither dismounted myself nor allowed the men to enter a single house, but sent for the authorities to come to me, and obtained from them the information I desired, and I then returned to the high road. Conceive my embarrassment when I found that my vedettes were gone. Supposing they had been surprised and enveloped by the enemy, I retraced my steps to the lines, where I astonished my comrades at my speedy return, but they could afford me no news whatever of my missing vedettes. I accordingly returned to the spot where they had been posted, and after a long search of every house in the vicinity, I found them dead drunk in a farmyard, to which they had been enticed by a farmer who wished to show his favour to the British by this act of hospitality. I need scarcely say that we were treated by the French inhabitants on the north of the Alps with the same attention as had ever been shown us in Spain, where it was often my fate to pass days and even weeks in the houses of the people, and especially the priests, without the expense of a single milrea or the apprehension of any personal danger.

Drunkenness is, sadly enough, the prevailing vice of our race; but it is

infinitely more sad to see it so common among our soldiery, because there are no troops in the world who so little need a fillip or the excitement of drink to induce them to do their duty and front the post of danger.

Colonel Wilbraham has expressed his regret that want of time did not allow him to go into the subject of patrols, and I would add my regret at this also, and that it did not allow him to go at greater length into the consideration of skirmishing. I think this is a matter not thoroughly comprehended by our people. As I understand its purport, it ought not to be regarded as an offensive act—at least it is not so in cavalry outpost practice. The object of skirmishing is to protect formed bodies from individual insult. When two opposing bodies face, an officer might daringly dash at the leaders of the opposing force, or fire at random some revolver or other offensive arm into the serried ranks, and not only cause casualties, but offend the susceptibilities of the troops. This is prevented by placing a rank of skirmishers between the troops in formation on both sides, as was wittily remarked on another matter, "comme un sac de coton entre deux vases de porcelaine." Again, skirmishers occupy the attention of an enemy while the larger operations intended are getting ready. It was my fate to be upon one of the longest skirmishes on record. On the night preceding the battle of Salamanca there was a dreadful thunderstorm, which frightened the horses in our bivouac, who broke loose, and scampered wildly over the country, the dragoons running after them to catch them. I happened to have secured my charger, and accordingly, on an order arriving for a piquet, I went with such men as I could collect. The storm passed over, and after a fine night the day broke, exposing the enemy right before me. It was about four in the morning. I immediately carried my men forward as skirmishers, and so continued on this duty till nearly eleven in the day, when I was called in to join my regiment; but I found it had been moved to the extreme right flank of the army. Thither I followed, and reached it at the moment when the advance was actively in motion to attack the Arapiles. I continued in rapid advance until the battle was ended at two o'clock in the morning, having been twenty-two hours on horseback. My horse died of the fatigue before the turn-out sounded next morning.

I have now to request the usual expression of your thanks to Colonel Wilbraham for a lecture not only most interesting in itself, but very clearly and intelligibly enunciated, and pleasantly illustrated. Our thanks are especially due to an officer of his rank and standing in the Army, because we must all appreciate one's own natural unwillingness to put oneself in the lecture seat, in opposition to all our habits, merely for a public good; but it is the more valuable to us, and yet more deserving of our thanks, when officers of reputation will attend to this duty, as setting an example to other officers of distinction and ability that I hope will be followed in this Institution.

LECTURE.

Friday, January 31st, 1862.

MAJOR-GENERAL W. WATKINS in the Chair.

AN OUTLINE OF STUDIES RECOMMENDED TO A YOUNG OFFICER.

By COL. W. H. M. DIXON, R.A. Superintendent Royal Small-arm Factories, Enfield.

IT has been said that "Military habits and organization are conducive to the best interests of society, even during a period of profoundest peace."

Accepting this statement in its evident meaning, viz. that perfection of discipline, training, and education in military men reflects not only honour and renown upon themselves, but is the true safeguard for the public weal, it will be my object to show to my younger brother officers how universally this truth is acknowledged, by what means its accomplishment is sought for in foreign armies, and how it can be obtained in our own.

Incidentally I must also touch upon the education, in some respects, of the soldier, as having a certain connection with that of the officer.

It is quite unnecessary for me to cite examples of the benefits conferred upon countries, and even the world at large, by accomplished and successful generals, or to point out the opposite results entailed upon kingdoms and empires by the weakness and ignorance of those military leaders to whom great interests had been committed.

Warfare as conducted by civilized nations is more dependent upon the results of scientific arrangements and combinations than upon mere physical or brute strength.

The object of a war is undoubtedly to cripple or destroy the material forces and defences of the enemy; but the general who accomplishes this object with the least loss to his own army is acknowledged to be a master in the art of war.

We can easily see the force, and acknowledge the correctness, of the statement of a French writer, who says that battles are the mere accidents of modern civilized warfare. For instance, two armies entering the field

in opposition to each other will eventually endeavour by a system of well-considered manœuvres to obtain possession of some point the occupation of which will exercise some very decided influence upon the results of the campaign.

On the supposition that both armies are equally well handled, and each has an equal start, if we may so call it, the probabilities will be that the operations of both armies will finally lead to a battle in order to decide upon the possession of this point.

On the other supposition—and the most natural because the most common one—of a difference in the quality of the generalship of the two armies, then it would most probably happen that the army best commanded would succeed in securing this objective point without the necessity of a battle, and, if so, would have secured a double advantage.

Again, the most skilful generalship is required at times to avoid the risk of being drawn into action upon unequal terms, or upon unfavourable ground.

On the other hand, to choose his own time, to manœuvre skilfully and confidently in presence of an enemy, and finally to take advantage of a faulty disposition to strike his blow, is the mark of a consummate general and accomplished soldier. I could not cite a better example of this than the lengthened manœuvres which preceded the battle of Salamanca fought by the Duke of Wellington on the 22nd July, 1812.

These illustrations will suffieiently explain the meaning of the statement that "those great military scenes which we designate by the name of battles are more the accidents of warfare than its principal or leading objects."

Having thus thoroughly imbued ourselves with the feeling of the importance to be attached to true generalship, we have only to agree to the proposition that there are no "heaven-born" generals in order to grapple fairly with the subject before us this afternoon, and to consider the description of studies necessary for a young officer to pursue, in view of his advancement to and employment in the highest ranks of his profession.

By the term "education of a young officer," which of course is the result involved in the studies recommended to be pursued by him, I understand not only the professional training required to be gone through to fit him for the varied military duties he may have to perform as a matter of duty, but also the developement to the utmost extent of all his faculties and energies towards the attainment of honourable distinction in his career.

In setting out with a high standard I do no more than any member of the learned professions might be expected to do, and whose example should hardly require to be much insisted upon by me in laying down my argument.

One supreme conviction ought to weigh with every officer who receives a commission, viz. that it is a trust committed to him by his country, a confidence reposed in him, and for no selfish or individual ends.

From this conviction springs the sense of duty as an incentive to action, and this is emphatically the lever which I must employ, as others have before me, to stimulate my younger brethren to exertion.

Well, then, if we start with the conviction that some military study is

necessary for every officer after he has entered the profession of arms, we may also lay down as a rule that successful study will be honourable to him.

It is worthy of remark that the periods at which scientific military education has most engrossed the attention of the great military monarchies of Europe are those in which great military operations have brought into strong relief the wants of the different armies engaged. During and after the Seven Years' War (a period which saw much of the present military schools and colleges spring into existence), the French Revolutionary war, and more recently the Russian war, the student of military history will see how indefatigably endeavours have been made to improve the education of the officers of the army.

Since the termination of the war with Russia, the whole public voice of England has called for a better education for our officers, and particularly for the staff of our army. The deep interest which the general public feels in the result of any war in which our country may be engaged makes them feel all the importance of having the fortunes of the country committed to able and competent heads as well as strong arms. If we turn to the Memoirs of Frederick the Great, we see the same anxious solicitude for the proper training of his officers, and the same complaints upon the inefficiency of his staff.

At the termination of the Seven Years' War he writes: "The position of the soldier may be left as it was before the war began; but the position of the officer is a point to which I am devoting my utmost care. In order in future to quicken their attention whilst in service, and to form their judgment, I have ordered them to receive instruction in the art of war, and they will be obliged to give reasons for all they do. Such a plan will not answer with every one; still, out of the whole body, we shall certainly form some men and officers who will not merely have their patents as generals to show, but some capacity for the office as well." And, again, in describing the difficulties in the way of impressing upon the minds of his young nobility the necessity for military study and training, he says: "They shrink from the army because it is a real training for the character; nothing is passed over in a young officer—he is obliged to maintain a prudent, regular, and sensible conduct. This is precisely what they dislike, and one hears the absurd and insolent expression, 'If my boy will not work, he will do none the worse for a soldier.' Yes, he may do for a mere man-at-arms, but not for an officer fit to be advanced to the highest commands, the only end of a good soldier's life, and which requires really extensive knowledge."

What Frederick the Great was then anxious for—what France and the other great military monarchies of Europe have, by different plans and with varied success, been striving after—viz., the highest degree of education capable of being imparted to an officer—presupposes, as a rule, a condition of obligatory work on the part of the officer. It is necessary for me to touch upon the objects sought to be attained by the obligatory system, and the results arrived at, as showing what is considered necessary for an officer to know, and how this knowledge is expected to prepare him for filling with credit the higher branches of his profession.

In the early part of 1856, a commission, composed of two officers and

a civilian, was appointed by the Secretary of State for War, "to consider the best mode of re-organizing the system for training officers for the scientific corps."

The commission furnished a Report on the specific subject to which their attention was directed, and also added to it "An Account of Foreign and other Military Education." This Report has been published in the form of a Blue Book, and contains the most interesting mass of information upon the subject of military education that has ever been collected together.

I intend to employ this Report as my text-book whenever I appeal to what is going on abroad or to the opinions of foreign military savans.

FRANCE.—In France there is a very broad distinction drawn between the requirements for an officer of the scientific corps and an officer of the line; for, while in the former case every endeavour is made to impart very high mathematical knowledge, in the latter a very moderate amount is considered sufficient. Let us take, for example, the Military College of St. Cyr. A fair, but by no means extensive, knowledge of mathematics is required for the entrance examinations only into this college. With the exception of some lectures on descriptive geometry and physical science applied to military art, the main teaching consists of military art and literature, history, geography, military statistics, fortification, and modern languages.

The whole system of instruction in this school is of a highly practical and useful nature. Young men intended for the cavalry are instructed in infantry and artillery movements and drill; just as those intended for the infantry are taught riding, and receive instruction in cavalry, as well as artillery drill and movements. This is considered a most important part of their instruction. "It is this," said the General Commandant, "that made it practicable, for example, in the Crimea to find among the old *élèves* of St. Cyr officers fit for the artillery, the engineers, and the staff; and for general officers, of course, it is of the greatest advantage to have known, from actual study, something of every branch."

I think that the system at St. Cyr shows more truly the peculiar military genius of the French nation, and what is required for an officer's education, than that at the Polytechnic School. At this latter there is a mixture of the military and civil elements; the higher prizes are those for the civil departments of the Government; and the traditions of the school, together with the high standing of its many distinguished scientific *élèves*, have all tended to keep up a very high mathematical standard, to the exclusion of literary and classical studies.

Agreeing that mathematical knowledge is necessary for the scientific corps of the army, and that it is a good educating agent for the mind and judgment, I am not at all convinced that the process of intense and almost exclusive application to such a study is one either called for by any branch of the army or calculated to make what is required—viz., a practical, as well as a theoretical, soldier.

It is even a question among distinguished French officers whether this process, as pursued at the Polytechnic, is not an exhaustive one to the brain of many of these young men, and injurious to them eventually. Excessive mental, as well as physical, training produces similar results;

and while in the Army we may for particular services require a better and more elaborate educational training than for others, yet in both the condition of a healthy, vigorous, active bodily frame is a *sine quâ non*.

The French may justly regard the Polytechnic as a great national institution—superior, very possibly, to anything of the sort in the world. But we must bear in mind that it is not purely a military school, and that very frequently those who get into the Artillery and Engineers are the lowest qualified of that school.

Staff Corps.—The entrance into the staff corps in France is through the school of application for the staffs, and the twenty-five annual vacancies in this school are filled up by three pupils from the Polytechnic and by a competitive examination between the pupils of St. Cyr and second lieutenants of the army. The vacancies mostly fall to the share of the pupils from St. Cyr. This at once opens out a wide career for an intelligent and ambitious officer. Once he is attached to the staff, from the result of a two-years' successful study at the staff school, he permanently belongs to it.

The course of study is worthy of remark, as combining in a high degree all the essential elements which constitute an efficient staff officer. They are: descriptive geometery, astronomy, topography and geodesy, geography and statistics, artillery, fortification, military art, military administration, manœuvres, German, drawing, keeping of memorandum-books, conduct and discipline, riding and knowledge of the horse. The work is done to some extent out of doors—such as military sketching; making plans of country, with and without trigonometrical points and distances; and plans of fields of battle, with descriptive notes and remarks.

It is worthy of remark that in France not much value is attached to any but compulsory study or training.

In their military schools we find that the young men do not study much by themselves. Whatever lectures they attend and take notes of are subsequently carefully and systematically gone over with them by a set of instructors, called, from their office, *répétiteurs*. The great object is to give their officers, or that portion of them who do not rise from the ranks, a careful professional education.

In the Artillery and Engineers this is principally given at Metz, and an extensive practical training is given to these officers after they enter the service, first by their remaining with the troops until they attain the rank of second captain, and subsequently being employed in the arsenals, workshops, and fortified places.

A short account of the regimental schools for the artillery and engineers of the French service will be very interesting, as bearing considerably upon the direct subject of my lecture.

These regimental schools are intended for the instruction, both theoretical and practical, of officers, particularly those promoted from the ranks, non-commissioned officers, and private soldiers.

It must be borne in mind that a considerable number of officers rise from the ranks in the French service, and consequently have much to learn theoretically after getting their commissions. These schools therefore have a particular significance, as showing that the French soldier when

raised to the dignity of an officer is not left without further means being provided him for obtaining a good education, and thus qualifying him for pushing his fortunes without any limit beyond that of his own intelligence and desire for advancement.

In Marshal Vaillant's report to the Emperor on the organisation of the Imperial School of Application for the Artillery and Engineers at Metz there occurs the following passage:—

"I beg to call your Majesty's attention to the dispositions of Article 65 of the Decree, by virtue of which any officers of the artillery and engineers promoted from the rank of non-commissioned officers may be authorised upon their own request to share in the instruction given at the School of Application. It has seemed to me that the whole career of education ought to be opened to officers who, being less favoured by fortune than their companions, have not received the same advantages of instruction before entering the service."

The regimental schools may be therefore considered as stepping-stones for this class, and also as furnishing the practical instruction in their profession to those officers who join their regiments from the School of Metz.

The instruction is broadly divided into two distinct portions, viz., into summer and winter instructions, the former comprising the regimental instruction, or that which exists in the interior of the regiments, and which is directed by the chiefs of those corps who are responsible for it, with the means placed at their disposal, under the general surveillance of the commandant of the school; and the latter, or winter course, which requires the assistance of the special means of the schools, or the employment of its professors and *matériel*.

To a considerable extent the instruction is imparted by officers of the two corps, and particularly to the classes of non-commissioned officers and privates.

A professor of mathematics and fortification is attached to each school. At the end of each course general examinations are held, and lists made out in the order of merit, with notes of the capacity and aptitude of each of the non-commissioned officers and men; and these lists are consulted in the formation of tables of promotion.

It is not to be supposed, however, that no professional teaching is given to officers of the line or cavalry after joining their regiments. The following circumstance will partly show how this is attended to, and tend still further to exhibit the system of careful systematic instruction given to officers upon subjects which are peculiarly within their circle of duties.

I was travelling with several young officers on a professional tour on the Continent, including, besides, an inspection of fortified places and battle-fields and a visit to the French camps of instruction.

At one of the camps, I was inquiring about the instruction given to the regimental officers in the manœuvre of a brigade and division, and how it was accomplished. I was told, that, previous to the brigade drill of the ensuing day, the regimental officers were informed of the nature of the movements it was proposed to execute, their object, and how they were to be carried out. A sketch or plan of the movements was drawn up, and every young officer had the subject explained to him in a kind of

regimental meeting presided over by the commanding officer, the latter having had the information from the general of brigade. Instead, therefore, of any movements being executed *à l'improviste*, or without due consideration, the whole subject had been previously discussed, and each manœuvre shown to be *à propos* to some object, or subsequent change of front or deployment. The camp was thus made one of positive instruction; and so systematic is the French military system on all subjects connected with the efficient drill, on *intelligent* and *intelligible* principles, of the officer and soldier, that the drill of the brigade is completely mastered by all concerned before the divisional drill is allowed to be entered upon.

May we not be allowed to account for the acknowledged superior intelligence in all military matters of French soldiers, and their love for discussing and criticising everything connected with professional subjects, by this system of giving rational explanations of the nature and object of military movements to all ranks, and thus enlisting on the side of well-considered and skilful combinations the intelligent appreciation of the mass? Is there any good reason why such a system, carried out even further, should not be introduced into our own service? I do not know that it would be advisable, on many grounds, to occupy a soldier's spare hours of an evening for such lectures or professional discussions, but an occasional alternation of a lecture instead of a drill would tend to vary the monotony of a camp life, by introducing a different subject to the notice of the soldier, and addressing his intelligence on points which are to be made the matters of actual practice.

I have no wish to force attention too much to the condition of the army in a neighbouring country, but I cannot help alluding to the physical education which is going hand in hand with the intellectual.

To an Englishman, who generally dislikes anything systematic, and whose natural bias is shown by a studied independence and individuality of act and thought, it may seem a strange spectacle, the attempt to develope by a progressively systematic method the physical powers of a large number of men, and for objects which are not immediately apparent.

And yet, according to recent accounts, most surprising results are being obtained by gymnastic drill or exercise on a very large scale, and its popularity is unquestioned.

Gymnastics of the French Army.—Mr. Steinmetz has given to the Institution a most valuable paper on this subject, and I cannot too strongly recommend every officer in the Army to procure a copy of the printed pamphlet. For both officer and soldier a physical training is pursued on a plan which must commend itself to every intelligent mind. These exercises to some extent take the part of drill; and, in fact, are preparatory to ordinary recruit drill.

The old Prussian system of setting up a recruit and teaching him to march, is superseded by one which is to teach him the full powers of his body, and so enable him to make use of his professional knowledge to the best advantage.

It would be of no advantage to a regiment composed of the most scientific men in the world to know that they ought to occupy a certain position, if, from defective training, a small amount of extra exertion had

incapacitated them from the capability of making the effort necessary to reach that position.

This simple truth lies at the bottom of all the improvements which are taking place in the French Army, and which to some extent were strikingly exhibited in the late Italian campaign. I allude to the celerity of movement and rapidity with which the French soldiers closed with their enemy.

I should not have satisfactorily terminated my short account of French military education, had I omitted to notice the physical education as a portion of their system. Depend upon it, that no nation can afford to neglect this most essential point.

To officers of the English Army, who are as a race passionately fond of athletic sports, and pre-eminently distinguished in them beyond any other nation, this lesson must not be thrown away. You will as a rule have to depend in the field much more on the physical powers of your men than on their intelligence. The latter it will be your province to guide and instruct; the former must have been the result of careful training, and cannot be remedied at the decisive moment, if defective, by the best will on your parts.

I really do not see why proper instruction in some central gymnasium should not be afforded to a certain number of non-commissioned officers from the various services, on a principle similar to that adopted in the French Army; and thus a good corps of Instructors raised for the Army, who should be under the supervision of some central control, similar to the Instructors of Musketry in their relation to the Commandant at Hythe.

I think every one will agree with me in the feasibility of the scheme, and, that it would become an exceedingly popular diversion, as well as drill, amongst the soldiers of the army cannot be doubted by any one. Yearly exhibitions might take place in regiments or camps of the results of this training, and small prizes awarded to the most proficient. I think that this proposal would tend to improve the army physically, and morally also, as it would soon discover the drunkard, the dissatisfied, or the sulky man. Such games, as the results of careful early training, were very successfully commenced and conducted by Colonel Eardley Wilmot, when commanding the Cadet Company at the Royal Military Academy, Woolwich. This physical development seems also to be wanted as a supplement to the high training in the use of the rifle which soldiers now receive. The two combined would make the perfect soldier.

In confirmation of these views, and as affording a striking illustration of the evils to be anticipated from a want of proper physical training, I would point to the disaster which befel the American Federal army at Bull's Run.

The "Times" of the 29th instant contains a leading article on the report of the Sanitary Commissioners appointed by the Federal Government to the head-quarters of General M'Clellan's army. This report states emphatically that a want of physical training and ability to bear the ordinary hard work of a soldier in the field was one of the causes which led to the severe losses the army experienced.

There does not appear to have been anything extraordinary in the amount of fatigue demanded from the soldiers of this army, and they had

not been exhausted by previous long marches or an active campaign, but, as the "Times" says, "It was their very first rapid march and the first loss of a meal which rendered them helpless and unfit for the work of a battle. Here lies the true secret of the whole affair. The men were only soldiers of three months' standing. They had never been inured to privation or even inconvenience. They could not carry their packs and muskets comfortably for a short march on a cool morning, least of all could they stand a mile or two at the double, which, indeed, might have tried older soldiers than they were. The consequence was, that when they got to the field, though with *good training* and *good arrangements* they ought to have been fresh as larks, they were in no condition to do themselves justice. They were brave enough, no doubt, and had will enough to fight, but they had none of that endurance which *training* alone can give."

In strong contrast to this, we have only to turn to the famous march of General Crawford's light brigade, which joined the Duke of Wellington after the battle of Talavera, having marched sixty-two English miles in twenty-six hours. Here is an example of what real soldiers could do in those days.

I do not think it necessary to describe similar, though not such energetic, efforts to educate the officer and soldier in Prussia and Austria as in France. The aim is in most respects the same, although the method is different, and the material to be worked upon varies very much from the impulsive, energetic, and reckless Frank.

The subjects, however, which form the staple for the professional training are identical, and are such as I shall have to touch upon presently.

I cannot, however, avoid inserting a portion of a Report of a mixed commission of military and scientific men presided over by General Lützow, as alluded to in the Blue Book from which I have already made several extracts.

"Instruction in pure mathematics in the military academy, particularly in the lower classes, must be considered one of the most important branches of teaching, not merely because the chief points in military science are founded on mathematical principles, but still more because a profound study of mathematics accustoms the head to clearness, accuracy, and method in thinking."

Again—"Geography, history, and statistics are the sciences by the study of which a young man comes in connection with the world before he knows it practically."

So again as to physical and historical geography—

"It is here particularly that, whilst we give the soldier a sufficient knowledge of preparatory science, we should point its application to the business of war.

"Without war, to gain some knowledge of war beforehand, to accustom the mind to throw itself as it were into the most perplexed circumstances of war, and to see what principles are to be applied to them, is certainly a great object in military science. Military geography helps us to do this; first, because without it the operations and conduct of a war are not intelligible; secondly, because the thorough knowledge of a country, both in its inhabitants and its physical geography, helps us to conceive the

course which any future war will take, and the best mode of conducting it. The first is the more elementary, the latter the higher practical and strategical, branch of the science. And this last requires so much thought and knowledge as to make it undesirable to teach it in a higher school. It should form the employment of a staff school. But detailed suggestions are given for a course of the simple kind of military geography."

That a high degree of professional education is considered necessary for an officer, is clearly shown by the accounts I have given of the system pursued for that object in France; and Prussia, Austria, Sardinia, and Russia are all engaged in improving military education. In fact it must march with the times, and advance at the same rate as general education and intelligence advances.

In our own service, with the exception of the Artillery and Engineers, the continued education of the officer, apart from the direct professional duties required from him, such as drills and field manœuvres, has not been hitherto attempted. The only school at present for officers is the Staff College, where a limited number obtain the information requisite to pass the examination for the staff. This appears at present to be the only test of professional excellence, and the only way to arrive at distinction in times of peace. This being the case, I almost think that the prize of a staff appointment should be made in a pecuniary sense a more valuable and a more permanent one.

The great mass however of our officers are left to themselves either to work out their education from individual predilections, or else to rest satisfied with that amount of professional information which will enable them to go through their ordinary duties without bungling.

I think that, if the matter were fairly and properly brought before the army at large, our younger officers would recognise at once the extensive range of information which ought to be mastered to a considerable extent before correct ideas can be entertained even upon merely professional points; and thus the want of a sufficient motive for further education would be satisfactorily met.

Whether in peace or in war, the officer who had tried to mature his judgment and cultivate his reflective powers, other things being equal, would certainly come to the front, and soon bring himself into notice. Is not this a motive strong enough for a military man?

The formation of camps of instruction in various parts of the United Kingdom is most favourable for carrying out any general scheme for the education of the officer, as the means or apparatus necessary to be provided could be better obtained for a large than for a small number.

The instructors would also have the advantage of illustrating their lessons by the actual exhibition of considerable bodies of men under manœuvre. It is possible also that sound criticism in relation to tactics and the method of handling troops under certain suppositions, and of occupying ground, might beneficially re-act upon older officers, and induce greater circumspection and consideration in arranging for the general drill and manœuvres of a brigade or division.

At first I would therefore recommend that young officers be brought together for the purpose of going through a course of reading on military subjects, such as strategy and tactics as taught by the best military writers.

If the subjects can be treated in the languages in which they are written, so much the better, but this at all events might be pursued with a few who were found competent and expressed a wish to do so.

Special histories should then be selected, which illustrate from actual campaigns the principles contained in the first subjects.

These histories will touch upon the three arms, their combinations and employment, with the special tactics of each arm.

Military topography, as a most essential element of instruction for all military men, will naturally engage a good deal of attention. It forms a very attractive subject for teaching, as it is so intimately connected with all military movements, and the works which treat of it in a military sense are profusely illustrated with examples of movements of armies guided as well as determined by the topographical features of a country. I think that no one could follow up this subject for any length of time without obtaining a large amount of collateral knowledge on military matters of a most useful as well as interesting nature.

Plan-drawing and field-sketching, with reports upon routes of communications, could be exceedingly well taught at the camps, and their usefulness and importance prominently brought into notice.

With the latter should be associated such elementary information upon geology as will enable an officer to describe the features of a country correctly, and to give other and valuable information dependent upon its geological formation.

A knowledge of the ordinary instruments employed for field-sketching can be obtained with little trouble, and particularly if combined with out-of-door practice at the same time.

The elements of permanent and field fortification would naturally form part of such a course.

The subjects enumerated are all purely professional, and such as can be easily acquired by any one who has the will and determination to make them his study. It remains now for me to show how this can be done, and to point out those authors whom I would recommend to be read and studied on the art and history of war.

Restricting myself still to the camps, I will suppose that military libraries and rooms or halls for study, drawing, and other purposes, are established there.

These means may possibly be afforded at the public expense, and should be supported by some small contribution from the officers in camp.

A body of instructors could, I have no doubt, be raised from amongst the officers of the three arms in camp.

Their qualifications however to act as instructors should be satisfactorily inquired into, either through the medium of the Staff College or through the adjutant-general of each arm.

The authorities might think it advisable themselves to nominate and pay these instructors; if so, a great point would be gained.

Should this however not be the case, I should think that any request by a body of junior officers in camp to be instructed as a class in any professional subject would meet with a ready response from some who are capable of imparting the requisite information.

In this way a beginning would be made, and pressure gently brought

upon the authorities to provide permanent means for instruction, such for example as are provided in the French regimental schools. I will suppose that the machinery is by some means or other established, artillery, engineers, and staff officers furnishing the instructors.

A class of young officers meet and settle to go through a course comprising the various subjects I have named.

The principal author for selection on strategy, I would recommend to be, without hesitation, the Archduke Charles of Austria; for, although his name does not appear as having *really written* the work on strategy attributed to him, the work bears such evident internal evidence of the fact, that we need not dispute it.

I would recommend this work to be most carefully gone through, each officer making a map for himself, if possible, and following step by step the whole course of the campaign, beginning with the passage of the Rhine by Moreau at Kehl, and terminating with the siege by the Austrians of this latter place. I would advise, although it might appear tedious, that every step in the operations of this master campaign should be traced.

It will thus prove a valuable lesson, and one which will not soon be effaced from the memory, besides giving most interesting topographical and geographical knowledge of localities.

Jomini on Strategy may also be strongly recommended, and employed usefully in connection with the former work.

After studying the principles of strategy, and their application to the campaign of 1796, I would recommend that some of Napoleon's campaigns, for example his first in Italy, commencing with the battle of Montenotte, be examined with reference to the strategy of the campaign, and a memoir on the subject drawn out; or it would perhaps be as interesting to take the campaigns of the Duke of Wellington in the Peninsula, and study them in a similar manner.

Maxwell's Life of the Duke of Wellington is a very good work to be taken for this purpose.

There are numerous examples also to be found in Marlborough's campaigns, including his famous march from the Low Countries to the Danube, ending with the battle of Blenheim, which may well serve as studies on strategical combinations: also the Seven Years' War. In fact, once a student becomes interested in the study of this higher branch of the art of war, the field of research opened out to him is inexhaustible.

For the study of tactics there are numerous foreign authors from whom good selections can be made. It would be well here not to confine oneself too much to one or two authors, but to read several and compare them.

A very elaborate work on tactics, containing a great deal of information and general criticism, has been published from the papers left by the Marquis de Ternay, a French nobleman and refugee from the Revolution of 1789. The work has, I believe, been employed in France as a text-book at St. Cyr, and a high commendation is passed upon it by M. Koch, who edits it, as being a work of great merit, and containing just what was required to form a good text-book on tactics, for teaching this branch of the art of war.

I think, to the English reader, it will be found rather pedantically written, and its style heavy and too dogmatic; but I also think, from having carefully read it, that there is much matter for reflection, and many judicious remarks.

Jomini is much more likely to interest as a writer, and his range is very considerable, extending throughout the Revolutionary War. Portions of his works may be selected to form a course of reading on tactics, and particularly the earlier campaigns of Buonaparte in Italy, which are considered as affording the best illustrations of the tactics of this great master in the art of war.

Templehoff, the historian of the Seven Years' War, and Decker, who has written on the same period (with special reference to the employment of artillery by Frederick the Great), together with General Lloyd's account of the Seven Years' War, may also be considered as valuable authors.

This period is well illustrated by the *Battle of Minden*, gained principally through the instrumentality of the English infantry contingent, by their bold attack on the French cavalry, the finest then in Europe, and showing that a tactical error in the disposition of troops on the field of battle may be productive of the greatest disasters. This error was in the disposition of the French cavalry, placed in the centre of the French army, and not sufficiently supported on their flanks.

Many such errors, and the unfortunate results generally attending them, are alluded to by the authors I have named, and should be specially noted for the information of the student.

Special tactics, such as the tactics of the three arms combined, of each separately, or combined two and two, are treated of in several foreign works. The most noteworthy are: Brunét's Histoire d'Artillerie, combining many notices upon the employment of this arm; Decker, de l'Artillerie à Cheval, avec la Cavalerie; Decker, Trois Armes; Favé, Trois Armes; Decker, Seven Years' War, noticed above, as showing the employment of artillery in that war.

I know of no English author who has treated of these subjects in a similar way, and I am therefore compelled to allude to foreign writers.

Having read these works, I can safely recommend them to any one as giving a variety of most useful information on the combined action of the several arms. Thought and reflection cannot but be stimulated by a perusal of such authors.

To the cavalry officer I would particularly recommend the work by Decker on the employment of horse-artillery and cavalry. He very justly remarks that either arm is the complement to the other, for, while cavalry possesses the offensive and artillery the defensive element, the union of the two arms constitutes the perfect military body, having both elements combined.

The first public lecture I ever gave, I recollect, was on the subject of the manœuvres of cavalry and horse-artillery, and I found this work invaluable as a text-book; I found that I could make the subject, by means of plans and supposed positions of the troops, both interesting as well as improving; nothing could better show the systematic handling of these troops, or at all events lead to correct views being arrived at on the subject, than such a work.

On the subject of general military history, and military literature, I would not wish to restrict the taste of any one by limiting his choice to particular authors. The best are known pretty generally, and good selections could be very well made by the officers instructing.

Some officers would doubtless like to refresh themselves by reading Cæsar's Commentaries again; the Chevalier Folard's Polybius would be within the power of any ordinary French scholar to read.

Vegetius on the Military Customs of the Romans, would prove very interesting. The student would trace almost all the modern customs in camp and on the march to the times of the Romans, and discover that General Crawford's orders for the Light Division in the Peninsula were remarkably similar to regulations in practice in the Roman armies.

However, it is more than probable, that, valuable as such reading would be, time would hardly permit of its being pursued to the exclusion of a tolerably complete course upon more modern military history, relating to operations on ground, and with means and appliances with which we are acquainted, and which to a considerable extent have altered the art of war in some essential particulars.

Topography, by means of the well-known work of La Vallée (which treats of the subject in a purely military sense), can be made a real means for imparting extensive military, as well as general, information. The work should be read, at first, in order to gain a general knowledge of the contents, and then employed as a work of reference in connection with the study of particular campaigns.

The work, as published in an abridged form, and translated by Colonel Jackson, contains the military topography of continental Europe, and as such contains all the information necessary for any one studying the general physical features of any country in Europe with reference to military operations in that country. Of course, it would be necessary, for particular purposes, to have more detailed information, and this can be got by the official maps of those countries; but for all educational purposes this work is sufficient.

At first, I would commence by taking a particular country—France, for example, which, as the author's own country, is probably best treated of. A skeleton map should be drawn, for the purpose of filling in afterwards merely the military topography of the country—viz., the frontiers bordering on neighbouring states, showing the physical formation, the natural and artificial obstacles, water-lines, roads, &c. The lines of fortified places on each side of the frontier would be shown on this map. Particular battle-fields should also be marked, as determining the sites which have been considered both strategetically as well as tactically important.

A knowledge of ancient history would help the student in attaching the proper relative importance to particular places which they have probably always borne—such as Toulouse, the central point of operations for the defence of the South of France, and Lyons, a similar point for the south-eastern frontier.

Again, it would be interesting to mark down in different coloured lines the lines of operations pursued by the various armies which have invaded France, commencing with the invasion by the Prussians at the early part of the French Revolution. A map of the above nature, carefully and

correctly drawn, and with all this information inserted, would give at a glance most valuable and interesting matter for a military man to meditate upon. I shall never forget my feelings when travelling through the Val d'Enfer, or the Höllenthal, in the Black Forest, after reading the stirring account of General Moreau's celebrated retreat through it; or the interest with which I examined the fortifications of Rastadt and the country leading from it up to the defiles of the Kintzig River, which opens a way through the Black Forest for an army to reach the higher Danube, after reading the Arch-Duke Charles's account of the retreat of the Austrian army by this route.

The careful study of this work would most certainly induce the habit of studying country with reference to military movements, either for offensive or defensive operations. The mind, as well as the eye, would become educated to regard military operations as based upon an accurate knowledge of the country which is to become the theatre of them, and hardly anything becomes in this sense too insignificant for the military topographer's notice. I allude to this because some not very thoughtful readers might be inclined to consider that La Vallée goes too much into minutiæ in his details of apparently insignificant obstacles.

Field-sketching would form a very interesting subject, and many officers would soon become quite proficients in this art. The immediate value of such an acquirement would be recognised by all, and, together with instruction in the use of the pocket sextant and prismatic compass, would enable an officer to arrive very soon at the next step—viz., laying down and making reports upon routes of communication, with all the collateral information necessary to be furnished to the proper department which has the charge of choosing roads along which troops have to march in an enemy's country. The highest degree of art in this important branch of duty is when an officer can manage to sketch rapidly and fill in his route from horseback. This requires a practised eye and steady hand; but it is the ultimate point to be aimed at by an officer who wishes to be a proficient in this art.

In order to sketch ground correctly, and give besides as correct information as possible, he should be possessed of some elementary notions on geology. Even a study of heaps of stone on the road-sides is of service, as indicating the nature of the formation in the locality, and giving also an idea of the probable condition of the roads themselves in bad weather, the indication being drawn from the nature of the materials used to repair them.

Every officer who has not had the advantage of a Sandhurst or Woolwich course should consider it a duty incumbent upon him to obtain a tolerable knowledge of permanent and field fortification, and take every opportunity of making himself perfectly familiar with the details of fortified places, and the relations which the various works bear to each other for defensive purposes. Should he travel on the continent, he will find numerous examples to study from, and gain also good notions of the improvement in fortification introduced by the German school of late years.

With respect to the periods of the year to be devoted to study, I would recommend a division similar to what I have described in the French regimental schools, viz. the summer season for the practical and out-of-door work, and the winter for reading, drawing, and theoretical exercises.

General literature, and subjects which, although not strictly professional, are yet portions of every gentleman's education, need not be dwelt upon here. These must be left for each one to select for himself.

My object has been to suggest subjects for study which bear directly on the profession of a soldier, but, in direct connection with all this, there must be a cultivation of other qualities, which are no less essential, in order to allow of an officer making use of his acquired knowledge for the public benefit. I mean that ready decision of mind and firmness of execution, which may be called by the name of promptitude, and which, together with knowledge—or, which is the same thing, power—goes far to make a perfect soldier.

If we think of these two qualities, viz. promptitude and power, as summing up in a general way all that I have said on intellectual and physical education, we shall see by a process of analysis all that is necessary to arrive at the possession of such rare qualities in combination.

A modern author, in a work entitled "Horæ Subsecivæ," gives an amusing though forcible illustration on this very point. He describes a large dog who has seized a small one by the throat, and is holding him in spite of all endeavours to call him off. Some one proposes to bite his tail; upon which an individual steps out with great alacrity from the crowd, and, seizing the tail of the *wrong* dog, bites it with determination. For this act he gets knocked over, very properly, by the indignant owner of the small dog. Here, says the author, is an exhibition of *promptitude* without *power*.

I am afraid we might also class in this category the charge of the Light Brigade at Balaclava. Why is it that so frequently our cavalry, from their individual bravery and eagerness, have called down upon themselves just rebuke rather than praise? Is it not owing to the absence of power, or knowledge, which should curb rashness, and that inclination to prompt action which that arm has frequently exhibited?

In the Peninsular War it was made more than once the occasion of very strong orders on the part of the Duke of Wellington, who reprobated in no measured terms the headlong impetuosity of the cavalry.

An instance of this unfortunate tendency is also furnished in Sir William Napier's History of the Conquest of Scinde. At the Battle of Hyderabad the precipitate and entirely unauthorised movement of the cavalry posted in observation on the right might have compromised the safety of the entire army. I bring forward these examples, not from any wish to bring discredit on this most gallant arm of the service, but simply to show that judgment based upon professional knowledge can alone be productive of good results. We may also sometimes see *power* without *promptitude*, and in either case the loss of the wanting quality is sure to mar a man's usefulness in life.

Then, again, the educated officer is ready for the opportunity when it arrives and is prepared to turn it to account. The old saying that opportunity makes the man, is, I think, entirely wrong, at least as it is generally understood and employed. Far nearer the truth would it be to say that *man makes the opportunity*. In this lies the whole secret of success in life, and from my experience in the work of professional education, and pretty extensive dealing with young men on their first entering life, I can safely say that this rule holds good universally.

Evening Meeting.

Monday, February 3rd, 1862.

Captain E. G. FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who joined the INSTITUTION between the 20th January and the 3rd February, 1862.

LIFE.

Staveley, C. W. D., C.B., Col. 44th Regt.

ANNUAL.

Frank, P. Staff Asst. Surg.
Molesworth, A. O. Lieut. Roy. Art.
Slesson, E. A. Lieut. Roy. Art.
Herbert, W. H. Captain 84th Regt. 1*l.*
Jackson, J. M. Com. R.N.
Ross, John, Lt.-Col., C.B., Rifle Brig. 1*l.*
Thesiger, Hon. C. W. Major 6th Inns. Drgs. 1*l.*
Swindley, J. E. Capt. 6th Inns. Drgs. 1*l.*
Billington, G. M. Capt. 6th Inns. Drgs. 1*l.*
Hardy, John, Capt. 6th Inns. Drgs. 1*l.*
Bennitt, W. W. Lieut. 6th Inns. Drgs. 1*l.*
Stevenson, Hew, Lieut. 6th Inns. Drgs.
Turnbull, G. A. Surg. 6th Inns. Drgs. 1*l.*
M'Master, V. M. Asst. Surg. 6th Inns. Drgs. F.C. 1*l.*
Hollist, E. O. Lieut. Roy. Art. 1*l.*
Smith, H. C. Lieut. Roy. Ind. Engs. 1*l.*
Mackenzie, R. Lieut. Roy. Art. 1*l.*
Nangle, W. C. Capt. Roy. Art. 1*l.*
Wood, H. G. Lt.-Col. 2 Batt. 8 King's.
Hennis, W. H. Ens. 2 Batt. 8 King's.
Shirreff, Rd. F. Lieut. 2 Batt. 8 King's.
Liddon, M. Ens. 2 Batt. 8 King's.
Dawson, John, Ens. 2 Batt. 8 King's.
Austin, E. F. Capt. Roy. Hosp. Chelsea.

AN ACCOUNT OF A LEAD-COVERED KARRACK OF THE MIDDLE AGES.

By Lieutenant A. T. Wyndus, H.M. Indian Navy, F.R.G.S., F.S.A.

In connection with the production of the paper I have the honour to read to you this evening, I feel it is necessary to explain that it was prepared in its original form exclusively for the Society of Antiquaries, being aware that, although the subject is a curious and interesting one in itself, as a link between the past and the present, and apropos of one of the great leading questions of the day—ships plated with metal, for defensive purposes—yet it is merely a communication that would interest any circle, though perhaps more peculiarly antiquaries. I here mean that there is

nothing practical to be derived from it, and, as we are accustomed in this Institution to endeavour to extract what honey we can from the papers that are read and questions discussed in this room, in the way of addition to our stock of information on the various scientific topics laid before us, I must deprecate the criticism to which I should naturally be exposed, if I volunteered the subject as one of real scientific and practical import; but this being conceded me (and I shall accept it with gratitude), I lay the matter before you with the greater confidence as a curious and interesting one, from which, by an after arrangement, since the first production of the paper, I trust we may make some practical deductions. Its more appropriate place, I believe, would have been as a sort of preliminary paper, spliced on to Captain Halsted's lectures of last year, and I did indeed offer to place it at his disposal, but he very kindly seemed to think it was worth working up into a special paper, which led to my laying it before the Council. Since then, in return for the consideration it received, and which has led to the reading this night, I have endeavoured to render it more worthy of your attention, by attempting to derive something of practical benefit from the shrewd scientific nautical ideas of the Knights of St. John, in 1530, by means of some experiments I have recently made on the resistance of lead to rifle balls, as compared with that of wrought-iron plates, which, with the permission of the Chair, I shall be happy to lay before you.

Before proceeding to read the paper I must also remark, that, as is often the case, I stumbled upon the subject by mere accident, while looking over a venerable volume, in company with my friend Sir G. Bowyer, who directed my attention, as one naturally interested in naval matters, to an account of the squadron fitted out by the Knights of St. John of Jerusalem, to operate, in conjunction with the forces of the Emperor Charles V., against Barbarossa, at the siege of Tunis. On going deeper into the matter, the account became so interesting, and some of the details approached so curiously to an engrossing theme of discussion and argument of the present day, that I really thought it worth introducing to the notice of the Society of Antiquaries, to which I belong, and the paper was drawn up, and read accordingly.

I therefore crave your indulgence to let the facts speak for themselves; the literal translation is rigidly adhered to—I have not attempted to strain points or ornament the details in any way.

After all, it is but drawing a parallel between two eras of ship-building, the very earliest and the very latest—I here mean war-ships carrying heavy artillery—in bringing the sixteenth and nineteenth centuries, the years 1535 and 1861, into a little closer contact, in point of nautical invention and contrivance, than one would suppose possible; in point of fact, I am about to introduce the crack ship of the Knights of St. John of Jerusalem—the "Santa Anna," of about 1,700 tons, built at Nice about 1530, to our Admiralty iron-sheathed crack ships of 1862, and to trace in the description some curious points of analogy—this is all I venture to proffer, and I trust these points will in some measure interest you.

The work from which I have made the extract, the translation of which I shall have the honour to read to you to-night, was written and published towards the end of the reign of our Queen Elizabeth, or about 1594. It is entitled, "Dell' Istoria della Sacra Religione ed Illustrissima Militia

di San Giovanni Gierosolimitano di Jacomo Bosio," and is dedicated to Monseigneur de Wignacourt, Grand Master of the Order.

The author, Jacomo Bosio (who, by the way, in the translation of this very work by Boyssât, published at Lyons in 1612, is miscalled Antonio Bosio), was a knight of the order, and it would seem quite devoted to its interests, as he appears to have entered *con amore* into the task he imposed upon himself of writing with great detail the history of the Sacred Order to which he belonged, the produce of his exertions being very voluminous, extending to three large volumes, containing much curious information upon the history and proceedings and the military and political influence of the Order of St. John up to the year 1591.

The detail in which he indulges will be clearly shown in his description of the Karrack, previously to entering upon which, however, I will, with your permission, and as briefly as possible, lay before you the circumstances that introduce her upon the scene.

It is the month of July, A.D. 1535. Muley Assem, the dethroned king of Tunis, has made an appeal to the Emperor Charles V. of Germany, imploring him to espouse his cause against the usurper Barbarossa. The Emperor, excited more probably by the *éclat* of the thing, and the prestige he would attain, if successful, in Europe, than for any particular sympathy with Muley Assem, has yielded to his entreaties, and with a splendidly-organised force set sail from the port of rendezvous, Cagliana, in Sardinia, on the 16th.

The fleet consisted of nearly 500 vessels, Flemish, Portuguese, Genoese, and a squadron fitted out by the Knights of St. John (always ready to engage the infidel), first and foremost among whose ships is our karrack, the "Santa Anna."

This formidable expedition was under the command in chief of the celebrated Andrew Doria, the most celebrated naval officer of the age, who was appointed High Admiral of the Fleet, and carried on board 30,000 regular troops, the flower of the regular armies of Christendom. The expedition arrived in the Bay of Tunis after a few days' prosperous voyage; the troops were landed without opposition, and the great fort of Goletta, which commands the Bay of Tunis, was immediately invested by land and sea. This fort of Goletta had been strongly fortified by Barbarossa at a vast expense, and he trusted chiefly to its strength and a body of Turkish soldiers, armed and disciplined after the European manner, for any chance of success against the veteran forces of the Emperor. To give an adequate idea of its strength, it may be stated that 300 cannon of large calibre, mostly of brass, were mounted on the ramparts—a prodigious number for that age, and a striking proof of the power of Barbarossa and the greatness of his preparations. It is the more necessary for my purpose to call attention to the armament of this fort, as will be seen hereafter, as for several days its formidable batteries played upon the invading force by land and sea. However, all these preparations were of no avail, the breaches soon became practicable; the fleet, with the great karrack holding a conspicuous position and gallantly playing her part, battered the fortifications with great fury and success; and on the 25th July, only nine days from the fleet leaving Sardinia, a general assault was given on all sides at once, and the place taken by storm.

I have compiled this account from histories of the period, more particularly Robertson's "Charles V.," which agree in all main points with our author, though he naturally enters more particularly into the special achievements of the knights of the order and of their squadron.

We therefore find this great Caracca della Religione, the "Santa Anna," laying off the port of Tunis, at the end of July, 1535, and most probably repairing damages in company with the rest of the fleet, after the bombardment. And I take up our author's account at the point where the recently restored King, Muley Assem, attracted by curiosity to see the galley which had exhibited such prowess, and from her size, fittings, and armaments, was the wonder of the day, proceeds on board to visit her; and the following translation describes her appearance.

Literal Translation.

"And he (Muley Assem) having seen the karrack of the Religione, "which caused him great wonder from her external appearance, became "desirous, above all things, of being conducted on board her, and to be "shown her internal arrangements, which was carried into effect, and he "was introduced on board by the bailiff (a Grand Cross of the Order) and "the Captain Touchbœuf, and received with all due honours and cere-"monies and a salute of artillery, as became his rank.

"And having returned on shore, he reported to the Emperor the wonders "he had seen, and that he believed he had never before seen anything so "astonishing.

"And, so much he said that he caused the Emperor (who, it seems, had "never been on board) to desire to visit her himself, which he shortly "afterwards did before he left the army. As it has been already said (in "a former part of the book), she had been already visited as the wonder of "the age by the Court of France, so that it appears convenient in this "place to give some account of her marvels, for, independently even of the "stupendous size of her anchors, masts, stoutness of rigging, admirable "machinery, and other appurtenances of her fittings, this karrack was a "superb and mighty vessel of war, and would carry ammunition and pro-"visions for a six months' cruise at sea, and was capable of carrying a much "greater freight than the karrack Grimalda, which, when near her, seemed "to be, so to speak, in point of size, her daughter, and yet she had taken "on board in Xiarca more than 40,000 salmi grosse of wheat of the "measure of Syracuse; and the other galleys, having often had occasion "to approach her, for the purpose of speaking her, the loftiest of their "spars barely approached within a foot of her great poop. She had six "decks (of which two were under water), all sheathed with lead and bolted "with brass, which does not consume lead as iron does, and, thus con-"structed, it was impossible to sink her, although all the artillery of a fleet "were fired against her. Her huge mainmast was made in pieces, and of "such size six men could not embrace it. She had three tops, one above "another, topmast above topmast, and constructed not merely for conve-"nience of setting the sails, but also to mount small pieces of artillery, "which she always carried. Her timbers were so strong and thick, that "having been many times engaged, and received much cannonading, she "was never pierced below the bulwarks.

"Old men still relate as a wonder that at the time of her construction a "great pestilence and mortality occurred at Nice, and caused so great an "infection of the air that even birds that passed over frequently fell dead, "yet no one perished among all the men who were employed in the "karrack on account of the great fires made on the shore, to carry on the "works of iron, pitching, smelting, forging bolts, &c.

"She had a large and spacious chapel dedicated to her name, Santa "Anna, also an armoury fully equipped with every sort of arm, offensive "and defensive, for 500 men. Also a reception hall, with inner rooms or "cabins, for the use of the Grand Master and Lords of the Council, and a "refectory where the knights eat, fitted up with all necessary accommodation, "lockers for plate, and table furniture. All her officers, who were double "in number, had convenient berths. She had various lodges and galleries "round the poop, and chests and boxes full of earth, wherein were planted "cypresses and divers other trees and flowering shrubs after the fashion of a "garden, small but beautiful. No one on board was obliged to eat biscuit, "as there was a constant supply of fresh bread, for she had the convenience "of hand-mills and ovens, capable of turning out two salmi of bread at "each batch. There was also no lack of abundance of sweet water.

"She carried a blacksmith's forge, so convenient for all purposes, that "three master blacksmiths were generally employed night and day, and "wrought with the same facility as if they were on land.

"She was entirely sheathed with lead from the bulwarks downwards, and "below the water-line bolted with brass bolts, whereby she was rendered "so water-tight it was never necessary to pump the hold out, except on "account of water which might have entered from above.

"But all her wonders and novelties were surpassed by the number and size "of her columbines and heavy artillery, which were mounted on her upper "decks, poop, forecastle, and waist, to the number of 50 pieces, besides an "immense number of pieces of lesser ordnance, of every size and calibre; "and she was marvellously furnished with every convenience for the gunners "who worked them.

"Lastly, to crown the perfection of this admirable floating fortress, she "was very fleet and manageable under sail, and easily worked, and in point "of ornament was decorated with many beautiful paintings, and numerous "pendants and flags. She carried three great lanthorns and a band of "music of trumpets and clarions. Her crew alone consisted of 300 men, con-"stantly on board. She carried two great boats of 15 benches hoisted up "to her poop, and beside these five others, and with these she had many "times captured Turkish galleons."

There are several points about this curious description of considerable interest to a professional man, and to which I will briefly allude presently; but the main one is obviously that bearing upon the topic of the day, *i.e.* the metal plating with which the sides of this huge vessel were covered. I submit to you that this karrack, "Santa Anna," was the "Warrior" of the period. Built at Nice about 1530, at the expense of the Knights of St. John, all the mechanical skill of the age appears to have been lavished on her construction.

It certainly appears from the description I have just read, that the

method of completely sheathing her with lead over thick timbers, below the *opire morté* or bulwarks, is especially brought to notice, and commented on, as a novelty. It was, no doubt, quite a new experiment.

That this sheathing or plating was manifestly intended for defensive purposes, appears by its having been applied to the sides of the ship immediately below the said *opire morté*, or bulwarks, and over the whole of the surface of her four decks, between the lower part of the bulwarks and the water-line, and thence continued below the surface of the water, with this difference, that brass bolts were used below the water-line, to counteract the action of the water. This circumstance shows the great forethought and general attention paid to the construction of this galley, as I will presently show that 200 years later scarcely a ship of the British Navy was sheathed at all, and when so sheathed iron bolts were used for a considerable period. But to return to the upper plating. Our author expressly states, that so defended it "was impossible to sink her, although all the artillery of a fleet were fired against her;" also, that, having been many times engaged, and received much cannonading, she was never pierced below the bulwarks. It has been already shown that she must have been exposed to a very heavy fire from the formidable batteries of Goletta, and no doubt the battering she there received is included. All I wish to do is to make my case out, that a metal-sheathed vessel of war did exist at this early date; that she was impenetrable to the artillery of the period; and, consequently, she answered the purpose of her designers, as we only hope our future iron fleet will, constructed by Messrs. Scott Russell, Samuda, &c., whom I heard so eloquently advocating the great cause of iron *versus* wood the other day at the Society of Arts. With regard to the sheathing below the water-line, it is a fact that no ship of our Navy was ever sheathed at all before the year 1761, 230 years after the date I have been speaking of. I find in the various records of the Royal Navy, that copper sheathing was applied first by way of experiment to a 32-gun frigate, the "Alarm," in November of that year. There was great prejudice, as usual, against the innovation, and it was not till 1764, in the month of April, that the operation was repeated in the "Dolphin," of 24 guns. It was not till the Revolutionary War in 1783 that this important principle was carried out in all the ships of the service; but mark, during all this time iron bolts were used. Apropos of the brass bolting of the sheathing of our karrack (brass being, to all intents and purposes, the same as copper on non-corrosive grounds), I find the following extraordinarily apposite remarks in "James's Naval History":—"In November, 1783, after various vain attempts to counteract the effects of the copper sheathing upon the iron bolts, it was ordered that copper bolts should in future be used under the load-draft of water in all the ships of the Navy."

There are many remarkable features in the equipment of this extraordinary vessel of war, showing a great advance in the age, for it must be observed that before this period ships carried no porthole guns, or, indeed, more than one mast. What her tonnage was is impossible to say with any degree of accuracy. From the description of a painting of her that exists on the walls of the Palazzo of the Knights of Malta at Rome, I am inclined to think she must have closely resembled her contemporary of England, the "Henri Grace de Dieu," built at Erith in 1515, but

about 500 tons larger, and probably carrying two more decks. It is not quite clear to me how our author reckons his number of decks; and possibly the two half-decks of the poop and forecastle, corresponding to those in the accompanying picture of the "Henri Grace de Dieu," might be meant.

I find, by way of comparison, the crew of the "Henri Grace de Dieu" consisted of 350 soldiers, 300 marines, and 50 gunners—about 700 full complement; so our karrack, by the provision made in her armoury, must have carried 500 fighting men, besides her working crew of 300, and the knights of condition and their establishment—in all, no doubt, exceeding 1,000 men of all ranks.

Her armament consisted, it is certain, of 50 heavy guns of one calibre, the "innumerable" multitude of other pieces being swivels—murdering-pieces as they were then called—falcons, sakers, and divers other pieces of strange nomenclature.*

With regard to her mainmast and its enormous size, I have no hesitation in saying that it was probably one of the first built spars that was ever made; it is stated distinctly to have been made in pieces; indeed, a spar of such magnitude, if described correctly, could not be otherwise, as no tree could have supplied it. I have consulted various works on mast-making, and early shipwright works in the dockyards of England, but can get no decided information as to when built spars came into general use beyond the middle of the seventeenth century, when there is no doubt they were generally used. Of course the invention refers itself to a time when ships increased in magnitude, and proportionate spars were required; but,

* THE HENRI.—The drawing of the "Henri," exhibited this evening, is re-drawn from the Pepysian Collection, in Magdalene College library, Cambridge, and I have re-drawn her on rather a large scale, as I think she must be something of the build of the karrack. In Durich's "Memoirs of the Navy," he says, "In these days (sixteenth century), since the change of weapons of fight, King Henry VIII. making use of Italian shipwrights, and encouraging his own people to build strong ships of war, to carry great ordnance, by that means established a puissant Navy." Consequently it is highly probable that the "Henri Grace de Dieu" was built upon an Italian model, and, being more of a show ship than for work, had more incumbrances given her in the way of poop and forecastle. It is impossible that a thing like that could have knocked about the Mediterranean as this karrack is reported to have done; and the "Henri" certainly never put to sea, except, it is supposed, on one occasion. She may be the ship that took Henry VIII. over to France in May, 1520.

In other respects, and judging from the description I have read to you, we may suppose the arrangement of the decks to be much on the same model.

Her armament from the original MS. is very curious, and throws some light on the naval equipments of the period:—

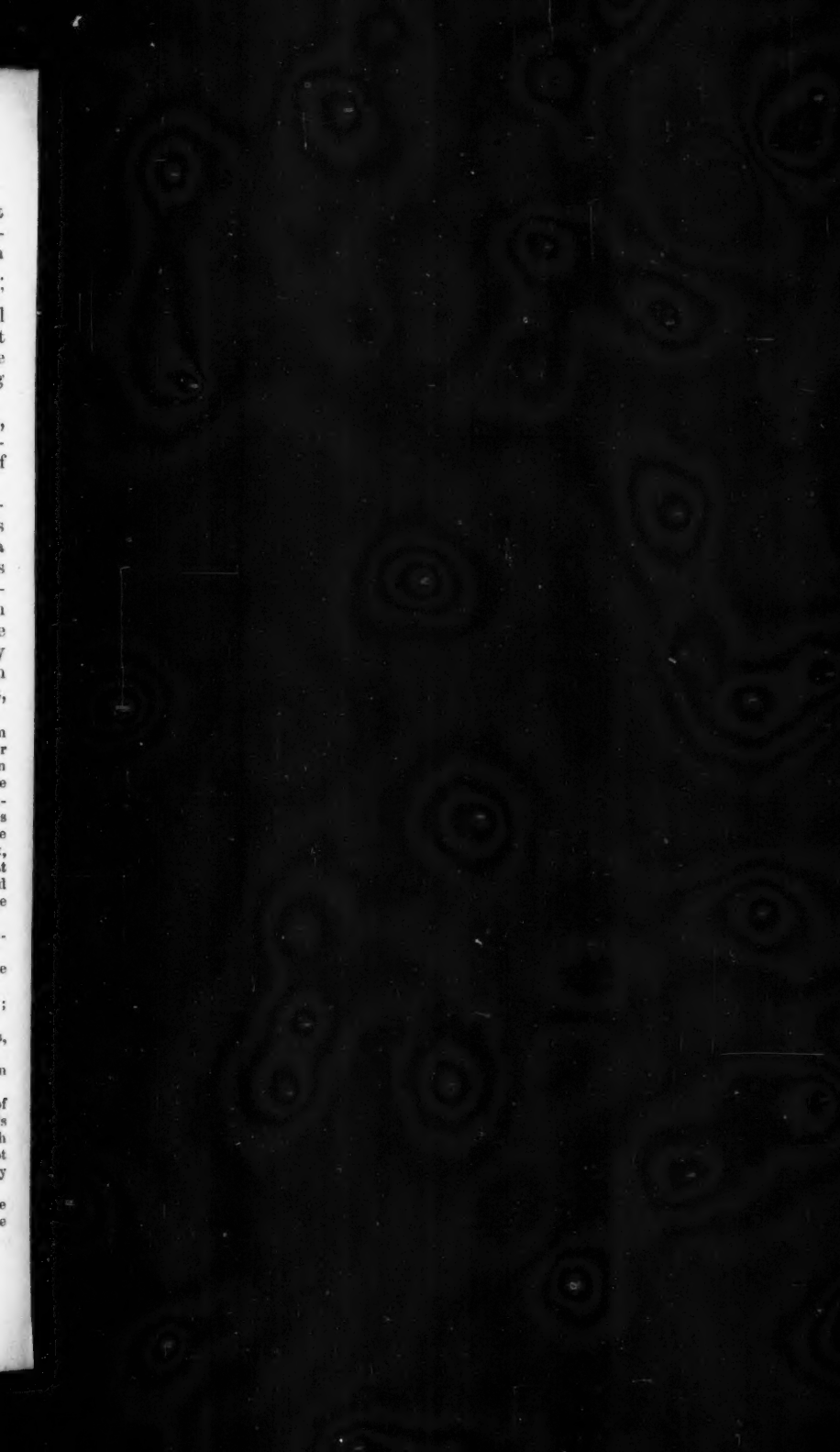
"Gonnes of Brass.—Cannons, 4; demi ditto, 3; culveryns, 4; demi culveryns, 2; sakers, 4; cannon perers, 2; fawcons, 2.

"Gonnes of Iron.—Port pecys, 14; slyngs, 4; demi slyngs, 2; fowlers, 8; baessys, 60; toppe peces, 2; hayle shot peces, 40; hand gonnes complete, 100."

A cannon, or cannon royal, was a 60-pounder; a demi ditto, 32-pounder; cannon petronel, 24-pounder.

Charnock remarks, with reference to the number of these guns, that a great many of them were of a very small calibre, and indeed would be called nothing more than swivels in these days, carrying a pound or a pound and a half ball. The "Henri," which according to report might be supposed to have carried 122 pieces of cannon, had not more than 34, according to the modern acceptation of the term, that could be properly so called.—A.T.W.

The plate now given is from a painting by Holbein himself of the "Henri Grace de Dieu," and may therefore be considered as authentic; it differs in some respects from the sketch in the Pepysian Collection.—ED.



THE HENRI GRACE DE DIEU, BUILT AT ERITH I
Tonnage about

Soldiers 3
Mariners 3
Gunners 1
Total Complement 7

AT ERITH IN 1515. (From a Drawing by Holbein.)
age about 1000.

J.R.Jobbins.

iers	*349*
iners	*301*
ners	*50*
omplement	*700*

in any case, I think I can claim for the karrack's architects the honour of being the originators, or certainly the first in the field.

The last point of interest about her which I will mention is a rather important one, for it touches upon provision for the inner man—the nautical stomach of the period. This redoubtable galley was so well provided with ovens, that she turned out daily enough fresh bread for all hands. What a blessing!—I speak feelingly myself, having been fed on biscuit for many a long day since the year 1844, so I envy these lucky sea-dogs of 1530 proportionately. I think Anson would scarcely have lost so many men in the old "Centurion," 200 years later, from scurvy and other diseases, if she had been fitted out somewhat after the fashion of this "Santa Anna;" for it is notorious, the wants and comforts of the seamen of our Navy were frightfully disregarded 100 years ago. I need only refer to Smollett's accounts of a man-of-war in George II.'s time.

A picture of the karrack exists, painted in panel, on the walls of a room in the palace of the order at Rome, and I regret that it has been impossible for me to procure an illustration of her; but, from all accounts I can gather of the painting, she resembles the "Henri Grace de Dieu."

There are many points about her construction and equipment which would be amusing to discuss in a naval coterie, but which I will not enter further into, as they do not bear upon the main point; but I really do think, by way of conclusion, that, taking all these facts I have laid before you into consideration—of course allowing for a little exaggeration of tone arising from the enthusiasm of the author, an enthusiast for the interests of his order, or anything touching the dignity thereof, but otherwise an honest and unimpeachable writer,—the subject is worthy of notice, merely from its associations. We all know in the course of miscellaneous reading how oddly we tumble upon passages that throw a light upon apparent unmeaning nomenclatures, a lustre upon some observance still kept up but forgotten in origin, that a thrill of interest is awakened almost involuntarily in our hearts as such light breaks in upon us; where could I, in the place where I stand, illustrate this more appropriately than by instancing a very matter-of-fact spot, only a few score yards off? We step from our cabs and omnibuses at Charing Cross, and proceed on our various routes of duty or pleasure. We never give much thought about the place or matter, except that our old historical reminiscences recall the funeral *cortège* of Queen Eleanor and the various crosses erected by good King Edward; but here the very name is significant in the last and most hallowed resting-place; and, in the mellow radiance of the light of archæology, prosaic old Charing disappears, and La Croix de la chère Reine stands forth in a halo of domestic affection, a memento for ever, while London endures, of the conjugal love which hallows the last resting-place of "the dear Queen." May we shortly hope to see another more substantial and enduring monument raised in our metropolis to the memory of one lately withdrawn from the same high station, where he shone as a star in our social firmament, who has passed from amongst us since this paper was written, and whose loss to this and all literary and scientific institutions was so eloquently deplored by our gallant Chairman at our first evening meeting.

Pardon the apparent digression while I make the application. Even so it is in this matter-of-fact age. I submit that it is worthy of notice—a

remarkable fact—that whilst in this year of grace (1861-2) all England is ringing with the great discussion, Iron *versus* Wood, as applied to vessels of war, and the merits of plated ships and invulnerable rams, &c., are warmly canvassed at every hearth, and in truth become very "household words,"—it is a remarkable fact, and one that brings home this very topic of the day to us as a nautical nation, always keenly alive to improvements in nautical science, or anything, indeed, touching upon naval matters, whether in their own or any other country, that 325 years ago, and contemporary with the first ship of the British Royal Navy, properly so called, that ever mounted a gun, a great vessel of war did exist, of which few of us, I may fairly suppose, ever heard, sheathed with metal, her sides impenetrable to the artillery of the day, brass-fastened, fitted with every convenience, carrying provisions for six months, baking her own fresh bread day by day for a crew of certainly 900 to 1,000 men and officers, also fitted with made spars and other improvements generally considered of much later introduction. I must, in conclusion, make these facts my apology for coming at all before you, and really I think they would seem to justify the old adage that "there is nothing new under the sun."

The only fact of real practical import to us in the curious description of this karrack, is that of her being cased with lead, and that this lead, overlaying thick timbers, resisted the fire of the artillery of the period; and this leads us naturally to ask ourselves, presuming all this to be true, and there seems no reason to doubt it, what are the properties of lead as a resisting medium, and why may it not be rendered available for the same purpose at the present day? It is only just that a subject of this kind should be ventilated, as it might posssibly prove of great importance; but, although much interested in the matter, it never occurred to me till very lately that I should myself be the means of introducing it publicly. Many scientific men, and men, too, who have had their attention particularly directed to this subject, have remarked to me, at different times, that they have had an idea of the application of lead to this purpose floating vaguely in their minds, but have dismissed it in consequence of the impracticability of obtaining experiments on a sufficiently large scale to effect any substantial proof. No experiments of any kind in lead have ever been made in England that I am aware of, but there were some in France, at Metz, in 1838. Captain Blakely has very kindly lent me a pamphlet containing an account of the practice carried on during that year against masonry, iron plates, &c., and the extract containing the experiments on lead I have translated, and will read to you presently, as it gives important information. Mr. Greener, of Rifle Hill Works, Birmingham, wrote me lately that he made some few trials of an iron ball against lead pigs, and that the iron ball was dispersed into innumerable fragments. He stated also that he suggested lead-casing for ships-of-war to the late Sir C. Napier, and that a correspondence took place on the subject, but it was concluded, without any experiments whatever, that the hamper would be too great on a ship's side in proportion to benefit derived. Having therefore no data to act upon, I determined to make a few experiments, as far as my limited means would admit, to determine what resistance lead would offer to rifle conical balls, which I think, from the peculiar nature of lead, is about the severest test to which

Lead Target 18 in^{s} square. ¾ in: thick

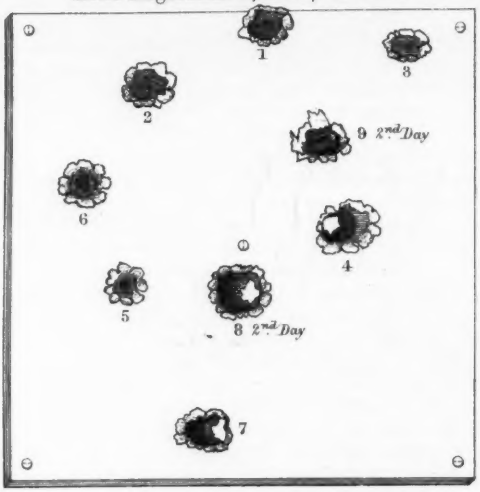


Fig. 1.

Scale 0 3 6 9 12 Inches

Fig. 2.

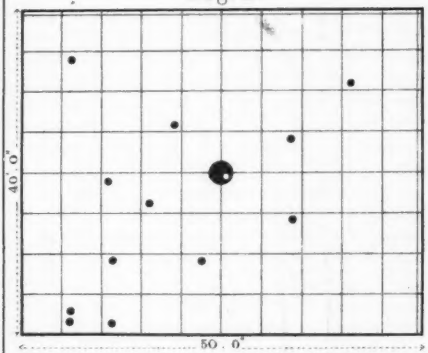


Diagram representing the practice on the 13th July 1858, by the late General Jacob, at 2,000 Yd^{s} with a Double Rifle made by George H. Daw. The Rifle was 32 Gauge; W^{t} of Barrels 8 lbs; Charge of Powder, 2½ drachms; W^{t} of Bullet, 575 grains; wind from the right and rear of the Shooter.

14 Shots Fired..13 Hits _ One Bull's Eye.

Fig. 3.

Actual apparent size of Target 50 f^{t} x 40 at 2,000 Yd^{s}

Bore of Gun

Scale ½ of an Inch showing twist 1 in 30

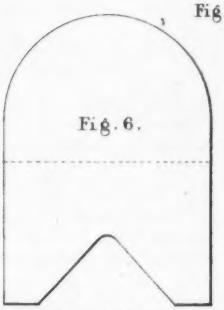
Fig. 4.

Section ½ full size of bore of 95 Cwt. Gun throwing an 80 lb^{s} Shot

Grooves ½ full size.

Fig. 5.

Fig. 6.



Section ½ full size 80 lb^{s} Compound Shot

J.R.Jobbins

it could be subjected. I have used a double Jacob rifle, 32 gauge, 24-in. barrels, made by Messrs. Daw, Threadneedle-street, one of the most perfect penetrative weapons that I know of. I am very glad to have an opportunity of speaking of this rifle, as its merits are above any eulogy of mine, and its effects are seen on the targets here by me (Plate A, fig. 1). The sister rifle to the one on the table by me, made on the last models of the late General Jacob, went out to Scinde early in the year of the mutiny, while this accompanied me to India a little later, and in a diagram I have here of some practice at 2,000 yards with it at Jacobabad shows its merits to be of no mean order (See Plate A, figs. 2, 3). I only allude to this to show that the experiments I made were conducted with efficient ordnance.

Now the question you will naturally ask is, What do I want to prove? —that lead is better than iron as a defensive resisting medium? Certainly not. I disclaim that at the very outset. But that lead might not be used in combination with iron, I do not feel quite so sure of. Supposing it possible to get over the grave objection of the enormous specific gravity of lead in proportion to wrought iron, which is as 1.48 to 1, and that three inches of lead on the sides of the "Warrior" are found to do the duty of the four-and-a-half-inch plating, and about equal the hamper on the sides,—should we derive any solid benefit by substituting lead for iron? The question of expense, of course, is important, but may be answered by the fact that lead always commands its price—like copper boilers for ship's engines, will always sell at market price when broken up. Also lead is a metal so easily worked that plates could be supplied at a rate not over 25*l.* a ton, including all expenses; whilst the wrought-iron plates of the "Warrior" are calculated to have cost the country at the rate of 50*l.* Again, repairs of damages could be very easily effected by a few ladlefuls of molten metal applied to shot-holes, and giving the ship a list for greater convenience. Lead is of that soft non-elastic nature, as we all know, that the whole force of a shot is brought to bear upon the immediate point of impact. There is no radiation of support, certainly, but then, from this very quality, no fracture can be occasioned in the rest of the plate—the damage is confined to the immediate point struck. I merely argue here the advantages that lead possesses, supposing it to be used; but as it is impossible to get over the fact of its enormous weight in proportion to its powers of resistance, or that 3¼ inches of pure lead, and, for the matter of that, 6 inches, will not do the work of 4½ of the best wrought iron, I will at once read you the report of the French experiments, and also of my own humble ones on the targets beside me.

EFFECTS OF COLLISION OF PROJECTILES WITH MASSES OF LEAD.

"A cast-iron projectile, which penetrates a mass of lead at the lesser velocities of 200 to 250 metres, does not break up, but causes a hollow of regular conformation in the mass. The metal, receding from the shock of impact of the ball, is forced up and outwards, and the mouth, so to speak, of the perforation formed in extending itself rips open, and presents the appearance of a serratic edging, similar to the acanthus leaves of a Corinthian column.

"With greater velocities the projectile is broken up, and the frequently numerous fragments cause a change in the regular appearance of the interior part of the hollow formed, but the exterior border still presents as bright and perfect an appearance, though more developed in effect. A shot fired at the velocity of about 380m. has given a consequent perforation of 0.280in. diameter, nearly double that of the projectile itself. A shot

of 2¼ calibre has been broken up into more than a hundred fragments, and the penetration has not been more than 0·16m.

"A shot of 8lb., fired at a velocity of 315m., which has been brought to the notice of the Congress, shivered into four principal fragments. The two targets of these showed fissures in addition, into which the lead, compressed by the impact of the shot, had introduced itself.

"The foremost surface face of the ball was forcibly flattened and widened out 0·009m. on a ring-shaped belt, the inner radius of which was about 0·335m., and the exterior radius about 0·065m. That part of the surface of the shot displayed concentric curvatures formed by the lead which had adhered there.

"SUMMING-UP.—Metal of the hardest nature, then, has been not only broken up by the concussion, but even its surface has been flattened down and depressed by another metal altogether the softest."

Although the summing-up of the results of the experiments is favourable to the resistance of lead as opposed to iron shot, yet we can gather nothing from them of any importance to justify the application of lead to the purpose we are discussing. The pith of the information we obtain is, that 0·16 metrēs (about 6in. English) broke up the spherical shot fired against it (what the whole mass of lead consisted of is not stated), but the experiments were evidently conducted to try the resistance of lead as a matter of comparison merely with masonry, &c., in masses, not to test at what point of minimum weight and thickness it would resist the shot opposed to it. It is evident the mass of lead was out of all proportion to the force of the shot; and we can gather nothing more from it than from the instance I have quoted of Mr. Greener's experiment, viz., that an iron musket ball broke up against a lead pig, which is a very solid mass of good 2½in. thick. But what we can infer is, that the fact of the lead being penetrated to 6in. by a spherical iron projectile solves the question of pure lead being inapplicable as a defensive medium; also that the cavities formed by the passage of the shot are in enormous proportion to the calibre of the shot itself.

Therefore all the experiments, with one or two exceptions, that I have thought it useful and interesting to make, have been with lead in conjunction with iron, altering the arrangements of each with respect to each other, for the better judgment of most effective application.

They are as follows:—

EXPERIMENTS.

First Day's Practice at Camden Park.

Against a target (see Plate A) of ⅜in. pure lead over ¼in. wrought iron backing, the whole bolted securely to 1¼in. birchwood; size of target, 18in. square; weapon employed, Jacob's double rifle, 32-gauge, barrels 24in.; pitch, four-fifths in the whole length; charge of powder No. 6, 2¼ drams.; projectiles employed, Jacob's lead conical, shell ditto, solid wrought-iron ditto, steel-pointed ditto; also an old pattern musket, "Brown Bess," was employed by way of comparison, with lead and iron ball.

Range, 30 yards. The shots are numbered on the diagram:—

1st.—Brown Bess, lead ball. Effect: A heavy bruising blow, the ball flattening up, and forming a coat to the bottom and sides of the nest-shaped concavity created by the impact of the ball.

N.B.—This effect seems to me to be much the same in proportion to that which was probably caused by the antique ordnance on the sides of the karrack.

2nd.—Lead, conical; Jacob.—The great penetration of this ball is obvious as compared with that of the musket ball, but the weak point of lead as a projectile is manifested by the appearance as here presented; the whole mass of the bullet is flattened back, and forms a cup, in the centre of which may be seen the hind part of the bullet, with the patch still adhering. The reverse side of the target in contact with the iron is starred with the force of the blow, but, as is seen, the lead has not been penetrated through to the iron.

3rd.—Solid iron, Jacob.—The effect of this shot is peculiar. The bullet has penetrated close to the iron, swooped off almost at right angles, turned back, and formed a nest for itself, so large that it easily shook out on moving the target. The ball is perfect, but the point is slighly curved.

4th.—Solid iron, Jacob, repeated, as I considered the deflection of the former (No. 3)

before penetrating to the iron backing, attributable to the point of the ball having turned slightly on concussion. This shot, it is seen, at once penetrates to the iron, dinges it in, recoils, and imbeds itself, broadside on, in the back part of the lead ; but the force of the concussion has shorn off the head of the ball diagonally, as neatly as if applied to a grind-stone.

5th.—Shell, Jacob.—The shell appears to have penetrated to much about the same depth as the plain lead conical ball before exploding, and the cavity formed presents much the same appearance, except that the *débris* of the shell (copper) are imbedded in the lead at the bottom. The whole cavity is perhaps very slightly larger than the plain (No. 2).

6th.—Another Brown Bess leaden bullet.—Scarcely any difference in effect produced.

7th.—Steel-pointed Jacob.—Certainly the hardest hit, and cleanest cut through of the whole number fired. Most of the lead is ripped off the shoulder of the steel point, which has inflicted a severe indentation on the iron and turned back into the lead.

8th.—This large hole (No. 8) was the work of a wrought-iron musket ball, made on purpose for me, and fired from Brown Bess, with a charge of 3 drams, at only 20 yards' range, on the second day's practice. By inadvertence, and owing to the target having been unbolted for the purpose of shifting the component parts as required, the iron backing was omitted, and the ball consequently passed clean through the lead, and expended its force on the wall behind. It would, no doubt, from its great initial velocity, have made greater impression than any of the conical projectiles from the rifle, and so forms a good comparison with the proportionate effect in heavy ordnance of the solid-shot smooth-bore guns, fired with high charges, at short ranges.

9th.—This shot, marked 9, was fired on the second day at the ¼-inch iron target, backed by ¾-inch lead, being a wrought-iron conical Jacob ball, at only 20 yards' range. The effect was remarkable. The iron is cut through with great force, and the jagged points driven into the lead, where they are seen still sticking, as also the ball remaining imbedded, broadside on, about ⅜-inch deep in the lead.

A shot succeeding this last was fired at the same arrangement of the target—¼-inch iron, backed by ¾-in. lead ; a Brown Bess leaden bullet, charge 3 drams, range 20 yards. Effect : Ball flattened up, deep dinge, and slight fracture in iron plate.

This shot affords substantial proof that lead projectiles cannot have equal effect to iron, when employed against iron. Neither the Brown Bess—at short range, with heavy charge—nor the Jacob rifle, could make any impression beyond a dinge and slight fracture, when charged with a pure lead projectile.

Second Day's Practice.

There is no diagram of these targets, as the plates were shifted nearly every shot.

Shot 1st.—Target ¼-in. best wrought iron, bolted over ⅜-in. lead, and wood backing 1¼ inch. Ball, lead conical, Jacob. Charge 2½ drams. Range 20 yards. Effect : Ball flattened up, dinge, and very slight fracture. This shot renders the proof more complete of the inefficacy of lead projectiles against iron.

2nd.—Steel-pointed Jacob ; target, range, and charge the same. Effect : The iron plate cut right through, the lead bulged into the wood. The steel point was broken up, apparently from the dead resistance of the thin plate of lead backing up the iron.

3rd.—Target, charge and range the same. Shell-percussion, Jacob. Effect : A slight dinge only inflicted, all further effect being prevented by the explosion. An analogous effect in proportion to a heavy ordnance shell against 4½-inch iron plates.

4th.—Target, iron plate, ¼-inch, backed with 1¼-inch birchwood ; no lead used. Projectile, steel-pointed Jacob. Charge and range the same as before. This shot is interesting as compared with No. 2, as it shows a decided advantage in the lead backing over wood. The jagged points of the iron are forced back, and driven into the wood, and the wood itself penetrated to ¾-inch, where the head of the ball is found—the lead stripped from the shoulder, and the steel head itself completely rounded off, as if with a file, in passing through the iron. In No. 2 shot the thin lead plating between the iron and wood broke up the ball, steel head and all, and prevented the throwing back of the jagged points of the iron.

5th.—Target ⅜ lead over ¼-inch iron. Charge and range the same. Steel point, Jacob.—This shot unfortunately struck just below the fracture of No. 2, and spoilt, to

the eye, the comparison referred to in note on No. 4. It passed through all, and lodged with great force in a brick wall behind, at about two inches depth.

6th.—The same experiment repeated. Effect: A very heavy and clean-cutting hit, the ball passing through all, and lodging in the wall. Both these last shots seem to show that lead in too small proportion for effective resistance is better applied as a backer to iron than before it, where it receives the first impact of the shot, as instanced in No. 2, where the steel-pointed ball, the most formidable projectile in my arsenal, was broken up by the lead after passing through the iron.*

I will not detain you long with the summary of these little experiments. That the lead forms a very efficient deadener or buffer to the iron is indisputable, and my iron plate remains almost intact, except two dinges, after exhausting all my hardest-hitting projectiles. I must here again deplore the want of another iron musket ball (which, in comparison with great guns, I may call my 95 cwt. 68lb. smooth-bore, which I believe most naval men are agreed as to its being the most effective armament for close quarters ever turned out); and one more shot so loaded against the iron plate over lead would would have settled the point to a nicety of their comparative resistances. But, from close inspection of the effects of the firing, I think I may safely say that an additional $\frac{3}{8}$ in. of iron would be fully equal to the $\frac{3}{4}$ in. of lead; and, if this deduction be correct, it is evident that lead for defensive purpose is useless against rifled ordnance, or indeed any ordnance of our times. That in the case of the karrack it was really of service I am fully convinced; but it was against projectiles fired from clumsy ordnance, having great windage, mealed powder, and stone and irregularly hammered iron shot. Then, again, in the junction of lead and iron there would be the antagonism of the two metals to be considered, which, combined with the moisture that must necessarily be experienced, would lead to the inevitable and speedy oxidysing of the iron.

Professor Miller, of the laboratory at King's College, who has made lead peculiarly his study, and with whom I have conversed on the subject, could suggest nothing better than a coating of tar on the iron when in

* Subsequent to these experiments, and the reading of the paper, the following three shots were fired from different rifles of well-known names, by way of comparison with the effects of the Jacob.

February 18.

The target the same as on first day, $\frac{3}{4}$-inch lead over $\frac{1}{4}$ inch iron. Range not more than 15 yards.

1. Whitworth.—Charge 82½ grains=3 drams; ball, mixed tin and lead. Effect: Flattened up into a cup on arrival at the iron. No effect on the iron whatever. The cut through the lead very clean.

2. The Henry rifle.—Charge 91 grains. Ball, pure lead. Effect: A clean-cut hole, and dinge on the iron, the ball flattened, and recoiled back completely out of the hole immediately on coming in contact with the iron, leaving not a particle of its substance behind.

3. Westley Richards' breech-loader.—Charge 75 grains. Ball, mixed metal. Effect: Ball broke up and formed cup at the bottom. No effect on the iron.

Remarks.—None of these shots appear to have made greater impression than the Jacob pure lead, and certainly nothing equal to the Jacob steel point. The effect of the Henry was something more than the others, but the charge of powder was very large in comparison, being 91 to 68½ grains, the charge used for the Jacob in all the experiments.—A. T. W.

contact with lead. Felt, which I suggested, would absorb moisture, and so be consequently unfit; and gutta percha, without infallibility, would be an expensive experiment. It is a curious fact, that lead rather preserves the iron, if you exclude the atmosphere or any moist influence, as may be observed in the sinking an iron railing into masonry, and soldering with lead; the iron corrodes at the point of contact with the lead at the surface, but below, where air-tight, it is preserved. There is also another great defect in lead, which the experiments bring to our notice; viz., the huge cavities formed, in proportion to the size of the projectiles employed. It seems to be attributable to the following cause,—that the shot passes through, as it were, water, or as a ploughshare cuts through the ground; none of the lead appears to be driven before the ball, as far as I can discern from the effects on the wood backing, but the action is lateral, and the lead is thrown away and back on all hands, leaving a gap of such magnitude that a second shot would strike upon a perfectly defenceless surface of the wood or iron intended to be protected.

Lastly, supposing lead to be all we could wish in other respects, a great bone of contention would arise as to the method of bolting and securing it. I should suggest as a mere matter of opinion that no bolting could answer; that, lead being so soft, the working of a ship would soon cause a play round the bolts, and all become loosened. Besides, of what material are we to compose the bolts themselves, with the very perfect arrangements provided for chemical action, in the presence of lead, iron, and water in the bolt-holes? The only feasible method that occurs to me in such a case would be to form the outer surfaces of the iron to be protected into a series of moulds, into which the lead might be run.

However, we may fairly come to the conclusion that no man's ingenuity will ever be taxed for this purpose, as long as we have good Low Moor wrought iron. If anything is to be done at all with lead, and if timber is still to be continued in the construction of our plated ships, I should suggest that a thin plating might be used with great advantage between the iron plates and the timber to which they are bolted; it would tend to tighten up all more effectually; and we know that complaints already exist of the water making its way through the interstices of the plates, and lodging between them and the timbers; and, in addition to this, I have shown the good effect of the *vis inertiæ* of a thin plate of lead, in counteracting the effects of a heavy blow and fracture of the iron, and prevention of damage to the timber from splinters of iron being driven in.

In conclusion, I do not in any way regret that I have made these few experiments on lead as a resisting medium, and apropos of the curious narrative of the karrack; and, if any interest has been excited in the minds of my audience to-night, I shall feel amply repaid for any trouble I have taken to elucidate the matter.

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Captain GRANT: My object is to derive some practical value from the information which you have been kind enough to afford us. With reference to what you have said about supplying the inner man with baked bread—what sailors call "soft bread"—have you any means of giving us details of the mode by which that was carried out? If you have, it would be of great value to us.

Lieutenant WINDUS: I have searched very carefully for any details; in fact, the secretary, Captain Burgess, particularly asked me on the point whether there were any details concerning these ovens. But there is nothing more said beyond mentioning the bare fact that there were ovens on board to bake bread for the supply of the crew. This crew was very large undoubtedly.

Captain GRANT: It would be of great advantage to be furnished with information upon that point. The Chairman will bear me out in that.

The CHAIRMAN: It would be very important. Were the dimensions of the karrack given?

Lieutenant WINDUS: No; there were no dimensions given beyond those which I have stated; you have it in general terms. Neither her tonnage is given nor anything else, except the remark that her mainmast was of such a size that six men could not span it. The thickness of the lead is not mentioned, only that she was covered with lead below the bulwarks. The calibre of the guns is not absolutely mentioned, but they may be supposed to have been 24 or 32 pounders—*i.e.*, the 50 porthole guns, called cannon. (See description of armament of "Henri Grace de Dieu.")

The CHAIRMAN: Nor of those in the Goletta Fort?

Lieutenant WINDUS: No; it merely states the fact that there were 300 brass guns.

The CHAIRMAN: It occurs to me that Captain Grant's ingenuity will make up for the deficient information with respect to the baking. I think with the quantity of fuel that is expended on board ship we might have a much better application of it. There is a great deal of fire goes up the chimney, and in all directions.

Captain GRANT: I maintain we have heat enough to bake all the bread that is wanted.

The CHAIRMAN: And to ventilate the ship as well.

Captain GRANT: Certainly; there is no question about it.

The CHAIRMAN: I am sure we are very much obliged to Lieut. Windus for his interesting paper. The information with respect to the karrack only shows the full value of an Institution of this kind for collecting facts. There is no doubt that, but for the ignorance displayed in our shipbuilding in former days, the value of copper and brass would not have been so long overlooked or have been so lately brought into use, if these facts had been known. The value of this Institution is in collecting facts of every description, so that inventors should not have to begin *de novo*, but should first come here to see what has been done. It is like a man going to read a paper upon any subject: he goes to all the authorities to see what has been written previously upon that subject. So in the case of our Institution, the inventor should be able to come here and ascertain what has been previously invented upon his subject. Therefore, all papers of the present kind are not simply interesting, but also useful.

In the reports of the experiments in France, there is information connected with these experiments which it would be desirable to give, viz. the velocity of the ball. It would throw considerable light upon the subject. There is no doubt it is the great velocity of the ball in Brown Bess which makes it so effective. It would, therefore, be desirable to ascertain in all these experiments the velocity of the ball in striking. It

would explain a great deal, and get rid of a great deal of unsatisfactory conflict of opinion about matters. The experiments I allude to are the more valuable, because, on a former occasion, Mr. Greener made some statements which seemed to be very apocryphal. Now, it seems from these experiments that that gentleman must have been under some misapprehension as to the facts. It is very difficult to get at facts; and his statements do not seem to have been founded on facts. Therefore, Lieutenant Windus has rendered a service in getting rid of these crudities, and I am sure you will all join me in thanking him very kindly for his interesting paper.

Evening Meeting.

Monday, February 17th, 1862.

Captain E. G. FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who have joined the INSTITUTION from the 3rd to the 17th of February.

ANNUAL SUBSCRIBERS.

Adams, F. Lieut. Bom. Staff Corps. 1*l.*
Lewis, G. E., Lieut. H.M. Ind. Navy. 1*l.*
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THE PRINCIPLES OF RIFLED CANNON AND PROJECTILES.

By James Lawrence, Esq.

It is the object of this paper to endeavour to define those peculiarities in the construction of rifled cannon and projectiles which have a claim to be considered as the principles on which they are constructed, and to show in what respects they differ from an ordinary gun and round shot.

In order to do this, I think it will be convenient, not, indeed, for the sake of information, but for the purpose of starting on firm ground, where the foothold is safe, to shortly advert to those principles which are common to both descriptions of ordnance.

An ordinary gun, equally with a rifled gun, depends for its power of propelling its projectile on the complete ignition of the charge, and its consequent conversion into a highly elastic gas.

It is not disputed that in an ordinary gun the shot should be well rammed home; and the object of this ramming is, that the powder should

be compressed into the smallest space, and the shot brought as closely as possible into contact with it, so that on the explosion taking place the violence of the expansion shall be at its minimum when first brought to bear on the shot. It is obvious that, if this is the case, the instant the shot begins to move, the explosive gas becomes increased in bulk, and, as the first impulse has to overcome the inertia of the shot, it is then that the greatest strain is thrown upon the gun. Now this is one of the principles which is common to both rifled and ordinary guns, and the initial velocities of their projectiles depends upon the proportionate ratio of the volumes of the elastic fluid to the weight of the shot. The next point in which these two kinds of projectiles agree, is their action on the air in passing through it from the mouth of the gun till they arrive at a state of rest. Without entering into any discussion as to the amount of resistance offered to different forms of projectiles propelled at the same or different rates of speed, it is enough for the purpose to say that the air always offers the same amount of resistance to a round shot propelled at a given rate, and always brings it to a state of rest in equal times.

The air acts on an elongated rifle projectile in a precisely similar manner, for it is clear that, supposing the elongated projectile is from its form better adapted for cleaving the air than a round shot, this advantage applies to the whole of the range.

It is, therefore, impossible that a rifled shot can begin slower, and then go on faster, as some ignorantly suppose, or even much further than a round shot. It has no reserve of power; cannot obtain what may be called second wind—in fact it must, and does, follow the ordinary laws of nature, and move slower and more slow every instant after leaving the mouth of the cannon. This principle, however, it has been attempted to deny in the case of rifle projectiles, and it was boldly asserted, at the Institution of Civil Engineers, that different laws regulated the flight of round shot and rifle projectiles. I venture to advocate the simplicity of Nature's laws, and to assert that they are fixed, immutable, and not under the control of man. We now come to the points of divergence, the most important of which is, that the shot being elongated, and not spherical, is made to revolve round its major axis.

The object of this rotation, as is well known, is to correct the irregularity of the density of bodies of metal.

Some one part of every shot is denser than other portions, and this heavy part always exhibits a disposition to get to the front, dragging the rest of the shot after it in the direction of its own position. A rapid revolution of the projectile, of course, corrects this by constantly changing the position of its heaviest part, and thereby counteracting its tendency to act on the other portions of the same body. This revolution of projectile which we desire to produce in rifling a gun, may be fitly termed a fundamental principle of rifled cannon projectiles.

By its means we get accuracy, or rather the power of obtaining accuracy; for accuracy really depends on the skill of the artillerist as much as, or perhaps more than, ever. We have not yet, at least, got—and, probably, never shall get—an automatic gun that will load and point itself.

There are many ways of producing this revolution; such as the numerous small grooves of the Armstrong gun, the ovals of the Lancaster

and Whitworth, and lastly, but by no means the least effective mode, wide and shallow grooves. (See Plate A, figs. 4 and 5, opposite page 109.)

The last I believe to be the best—most certainly the best if cast iron is used; but, whether small or large, oval or hexagonal, none of them contain any principle; they are simply matters of convenience, and are only worthy of consideration as to their relative advantage in giving rotation to the shot with the least reduction in the strength of the gun. The revolution of the shot is attained by making an elongated projectile revolve on its greater axis, and is effected by friction against grooves formed in the bore of the gun; and this is another point in which it differs from a round shot fired from a smooth-bored gun.

A perfect rifled projectile is, for a reason which I will presently advert to, also necessarily expansive—that is to say, when it is fired it fills up the groove of the gun, and completely annihilates the windage.

The windage in a smooth-bored gun not only detracts from the accuracy of the shot, but subtracts from the strength of the powder, by allowing an escape of gas, and even of un-ignited powder, which an expansive, and, as I contend, perfect, projectile prevents. I repeat perfect, because such a projectile absorbs every portion of the force which is used to put it in motion. This friction against the sides of the gun is, therefore, an entirely new element in artillery practice; it is also an element of danger, tending to strain the gun; but, as it is also a necessary evil, the greatest care and intelligence should be brought to bear on the means of reducing this dangerous element to its lowest point. In every machine used for commercial purposes this is a primary object, and the whole art of a mechanical engineer may be said to consist in combating friction; for, after the principle of a machine is once settled, the reduction of friction by accuracy of workmanship, and the simplification of the parts, is the sole aim of an intelligent mechanic. In a rifled gun this object is effected, I believe in the best manner, by reducing the twist of the rifling; but, as this is a moot point, I will pass to one on which there is now no difference of opinion, although I at one time stood alone in advocating it,—I mean the necessity of greasing rifle projectiles for artillery. I saw the necessity of this at the first experiment I made in 1852, and in a letter to the late Lord Hardinge, which I apprehend is still to be found at the War Office, I pointed it out. This idea was totally opposed to all antecedent practice, and I had to bear the whole weight of the obloquy that is sure to attach to any putter-forth of strange doctrines. "Grease a cannon shot!" said the late Lord Raglan, "who ever heard of such a thing?"

Even so late as December, 1859, the same prejudice existed, and I had the mortification to witness the bursting of a 68-pounder gun of 95 cwt.—the only accident that ever occurred in my presence—because the artillery officer chose to consider that soft soap was a fair equivalent for Russian tallow, and would not believe that the lubrication of the projectile could have any effect on the life of the gun.

The principles just stated, although few and simple, will, if established, form a sound basis for the proper construction of cannon, and enable us to criticize, with assurance of accuracy, the pretensions of any novelty in the make of guns.

They define the relative position of the artillery officer and the mechanical engineer, and show that, so far from accurately-made guns supplementing the skill of the soldier, they task his abilities in a greater degree than ever, for a good rifled gun improperly directed or elevated is perfectly certain to miss the mark aimed at, and is not subject to the chances of a smooth-bored gun.

The ranges form an admirable test for the relative efficiency of rifled cannon, for it will require but this knowledge to decide the point with unerring certainty. Again, the motive power of projectiles being reduced to the simple element of the explosive power of gunpowder, no expectation of wonderful or extraordinary effects can be rationally entertained until some agent stronger than gunpowder is produced.

A larger gun may produce greater effect than a small one, but it will bear a strict relation to the weight of the powder and shot used. As well might we hope to get wonderful and hitherto unheard-of results from the power of steam, as from that of gunpowder. We have, in the one case as in the other, got perhaps near the end of our tether; and there ought to be no reason why a particle of doubt should hang over the results of rifled artillery practice, any more than on the duty to be obtained from steam. If it is otherwise, it is because every means has been taken to mystify and confuse the one subject, while in the other every vestige of quackery has been carefully expelled, and the facts have been rigorously sifted and investigated by men combining intelligence with honesty, and having no motive to deceive.

A few words, perhaps, may be allowed on the supposed advantages of very large guns, and to judge of this it should always be borne in mind, that, although we can make guns of any size we like, the men that are to use them can neither be made taller nor stronger, and that therefore machinery for loading any guns much over the size of those in present use must be employed, and this ought to be conclusive against their uses, as far as siege artillery and broadside guns are concerned.

The principles on which rifled projectiles are constructed may be reduced to two. The first, which must be considered rather rudimentary than perfect, is the projectile which is formed entirely of iron, and which is made to rotate either by projections on its sides, fitting into grooves in the gun, or by giving to flat surfaces a twist or pitch, answering to the internal arrangem et of the gun.

This form is in great favour with many persons who imagine that the liabilities of a gun to burst are greatly lessened by the shot being inexpansive and that the shot itself is more efficient from its being homogeneous, and not a compound projectile. There are, however, disadvantages: for unless the shot is made very carefully, and consequently very expensively, so as to reduce the windage to the lowest point consistent with its passage through the gun, the efficiency of the shot is reduced to that of the round shot it is intended to supersede. The result of making it fit tight is, that you have a shot much more liable to burst the gun it is fired from than a compound shot, because, if by any chance it sticks, the rigid character of the shot renders compromise impossible, and something must go. Even on the most favourable supposition that the shots always

fit as tight as possible, and never stick fast under any circumstances, the effects and ranges of such shots must always be variable, and in actual warfare exceedingly so, on account of the expansion of the gun by frequent firing, which, with a rigid inexpansive shot, must increase with every round.

The second principle is that of coating iron, more or less, with lead or zinc, forming a compound projectile. The objections just adverted to, are here evidently obviated, because the zinc or lead, being soft and expansive metals, have the necessary capabilities not only for filling the grooves of a gun at the commencement of firing, but also of allowing a margin for the expansion occasioned by rapid discharges during action.

They have a further advantage. The powder is more perfectly ignited when the shot is expansive, and it is found in practice, that, even with increased range and efficiency, a reduction of the charge, as compared with the charge for iron shot, can be made, amounting to between one-fourth and one-eighth.

These are the two principles which regulate the construction of rifled projectiles for artillery, but there is a modification of the last to which I must invite attention. It is the using two soft metals, as compounds instead of iron and lead. (Plate A, fig. 6.)

The effect of this is, that while with iron alone, or in combination with lead, you have a winged projectile, with the compound of soft metals you possess a missile which has properties not fully developed until the shot strikes.

This peculiarity is so entirely opposed to the prejudices of nearly every person, whether military or civil, that it is not wonderful it should have been so long overlooked. A shot compounded of zinc and lead strikes a harder blow than iron, and, curiously enough, it is against iron that this superiority is most remarkably manifested.

The reasons for this are twofold—the first arising from the fact that the harder of the two metals can be placed in front of the softer, so that at the moment of impact the softer metal behind yields, and the somewhat harder metal in front strikes against the far harder iron plate, and has little tendency to crush up; and the second, because, these metals being inelastic, they do not rebound like iron against iron. Iron against iron will make a hole, but the soft metal projectiles alluded to, not only make a hole, but effect an entrance; and the stoutest iron yet placed as a protection on vessels of war will not resist a shot of 60lbs. to 80lbs. weight, made on this principle, and fired from a 68-pounder.

These shots have been sent in very large quantities to America, and I believe elsewhere; but, although the inventor of them, I have never yet been able to get them fairly tried in my presence at home; notwithstanding, from circumstances with which I have been made acquainted, I have reason to believe that they have been made at Woolwich, and have still better reason to know that whole shiploads have been sent to America.

For myself, personally, I have had nothing to do with the manufacture of more than one shipment of some 1,500 9-pounder projectiles.

I will now conclude these observations by describing the trial of a new kind of shell—one of which is on the table—which is intended to penetrate iron, and was tried in October last at Shoeburyness.

Although the trial was so recent, the idea was hatched in 1856, when, after completing some experiments with solid shot, which to this day have not been surpassed, I made an unsuccessful application to the War Department to have a few shells tried.

Having, however, had the pleasure of hearing the papers on Iron-cased Ships read by Capt. Halsted in this Institution, in which he stated that ⅜-in. iron would keep out any shell in the service, I resolved to try again. In this resolve I was not solely actuated by self-conceit, but from memory of an experiment which I witnessed some years previously at Woolwich, when my soft shots were pitted against granite, and, as they made a great impression—1½ in. deep—in the stone, I argued that they would be equally effective against iron.

I was likewise aware that there was a general impression in the Navy that shells were more dangerous than solid shot, and on one occasion a gallant officer expressed this opinion by saying, "For God's sake, keep out the shells."

I accordingly wrote to the present Secretary of the Admiralty, who was acquainted with the commencement of my experiments in 1852, as well as personally acquainted with my late friend and patron Mr. Muntz, the Member for Birmingham, offering to make an 8-inch shell that should perforate 3-inch iron plates. Lord Clarence Paget referred me to the Secretary of State for War, who, acquiescing, referred me to the Select Committee at Woolwich. The Committee were willing to try the shells, but I wanted to test the matter on a small scale first, and I had some small shells made three inches in diameter. Unfortunately the Committee had no gun that would fire 3-inch shells, but stated that if I made some 4-inch they would not object to try them. This I did at some trouble and expense, but with a clear written understanding that the trial was to be a preliminary one, and that the shells should penetrate 1-inch iron.

When the shells were made and sent to Woolwich, the Select Committee handed me over to the Special Committee on Iron Plates. This body, however, reported to the Admiralty, they having no control over guns, being in this respect like the Admiralty; and they had no money to make experiments, the 15,000*l.* voted for that purpose having been taken from them when they were transferred to the Admiralty.

The gun at length furnished to me was an old iron one, cast some time in the reign of George III., and rifled on a principle which no person has ever since then advocated.

It was considered unsafe by the officers, and was fired with a long lanyard, and every one present was obliged to get under cover at each discharge, an arrangement that precluded careful observation. Bad as the gun was, however, it did not burst, and the shells went through the 1-inch plates with the greatest facility.

It appeared, however, that these soft-metal concussion-shells were expected to go through iron plates whole.

What they really did, however, was not very much short of this: that they went up to the iron *whole* was admitted, and as the time occupied in passing through the iron was but the 24,000th part of a second, and they carried their fire and fragments in with them, the difference was not much: but it was determined that the experiments should not be renewed.

The following week witnessed those experiments with the 100-pounder Armstrong guns, which proved that, in penetrating effect, they were inferior to the service smooth-bore artillery.

I suppose this abstinence from penetrating was ascribed to the good taste of the guns; it certainly has resulted in giving them a higher reputation, and in bringing them more extensively into use.

As to myself, I have spent nine years on these experiments—endured much labour—and spent some money. I had borne disappointment, and the sickness of hope deferred, with fortitude, though it at last has brought on a nervous affection of the heart, from which I have recovered so slightly that my appearance here this evening is not without risk, and nothing but a sense of the duty of fulfilling a voluntary engagement has induced me to be here.*

Extract from Official Reports of Experiments, showing Times of Flight of Rifled Projectiles, Form and Hoist of Grooves, as well as Depth, suggested by Mr. Lawrence.

Weight of shot, 80lbs.; charge, 12lbs.; weight of gun, 95 cwt.; length, 10 feet; twist, 1 in 30; grooves, 3; depth of grooves, $\frac{1}{10}$th of an inch; equal lands and spaces.

5″ elevation	2,595 yards	7″ =	1,112 feet per second.		
10″	„	4,100	„	15″ =	946	„
27″	„	7,300	„	30″ =	730	„

Mr. LAWRENCE is desirous of adding to his remarks that he has actually witnessed a direct trial of the relative time occupied by the travelling of round shot and rifled projectiles of the same weight and propelled by the same charge. In that experiment the rifled shot went from 30 to 50 per cent. further than the round shot in equal times.

Commander ROBERT A. E. SCOTT, R.N.: I may be permitted to say, with respect to the velocity and range of projectiles, that if an elongated shot be fired at 10 degrees of elevation, with an initial velocity of 1,800 feet a second, and a round shot of similar diameter be fired at the same elevation, with an initial velocity of 1,600 feet, the range of the elongated shot will be considerably above 3,000 yards, and the range of the round ball will be under 3,000. This, I think, shows that Mr. Lawrence has made a mistake in saying that the velocity with which a shot leaves the gun determines the range. Also if a heavy elongated shot leaves the gun with a low velocity it will very possibly have a longer extreme range—that is, when you give the highest elevation, it will range further than a lighter elongated shot of similar diameter, which may leave the gun at a much higher velocity. With respect to what Mr. Lawrence says as to the expansion of shot, it must be remembered, that, in expanding out projectiles to take the rifle grooves, you very suddenly throw a great strain upon the gun, and call into play a very large amount of friction during the shot's passage through the bore, and in thus stopping the windage you really close the safety-valve of the gun. The next point which Mr. Lawrence has noticed is, the expansion of the gun from getting warm. The gun certainly does expand, but it is only in a trifling degree. But, granting that it did expand to a greater degree, what would be the effect? That, when your gun got hot, and the combustion of the powder became more perfect, the lead would be driven out more violently against the bore, which would

* The author has since died.—ED.

more suddenly cut off the windage and throw a far greater strain on the gun. An iron shot, on the contrary, does not expand by the explosion, and hence gets more windage as the bore warms, so that its safety-valve gets larger as the gun expands and becomes weaker. With regard to simple cast-iron projectiles, there is a specimen placed on the table which can be cast at the same rate per ton as the round iron shell, and the subsequent planing of its bearings and zincing cost about three-halfpence per shot. But rifling is principally valuable on account of its giving the means of throwing a shell of large capacity. It has now been tolerably well ascertained that the simplest and best way to break iron plates, without straining the gun, is to fire round shot. All foreign nations are now striving to combine with the advantage of rifling—so as to use the elongated shell—that of still firing the round ball. Elongated shell are however only valuable if they have a great powder capacity; but if you took two metals—zinc and lead—and joined them in the way proposed, you would really have little or no powder capacity. Besides this, such a shell would be enormously heavy if made of the same diameter and of equal strength with this cast-iron shell for a rifled 32-pounder, which contains 5lbs of powder and weighs only 38lbs., or 6lbs. more than the round ball for the same gun. It is a common error to suppose, that, because a projectile is lead-coated, the strain upon the gun must be less, on account of the softness of the metal, than if the projectile were of iron only. Take the Armstrong shot: this, before the lead (hardened by tin) mixture is put on, is nearly the size that an iron rifle shot would be for a similar bore; and, when the lead is run on, it is larger than the bore. Hence, when the charge is ignited, an immense force is expended in compressing the lead, and squeezing it almost instantly into so many grooves; and consequently the strain upon the gun is enormous. Windage, on the other hand, if only a moderate amount be given, is an advantage, not only as a safety valve, but as a means of cleaning the bore of the gun; it also further reduces the strain by driving out the column of air which would otherwise impede the motion of the shot. When Mr. Whitworth fired a tight-fitting projectile, he did not get so great a range as that which he obtained afterwards on sloping away the bearings, and giving the projectile more windage; but what would be the effect of closing the windage by an expanding shot, if you placed a wad in front, in case of being at sea? The want of a small jet of gas to blow out this wad would very dangerously raise the pressure upon the gun; but with an iron projectile, where the windage is not closed, no such danger could occur from the placing of any wad to keep the charge "home." A wad would always be necessary if the vessel were rolling, and a vessel nearly always rolls if her engines be stopped.

Mr. LAWRENCE: Does Captain Scott mean to say that, with a difference of range so great between the elongated shot and the round shot, the diameter of the two shots is precisely similar, or that merely the weight is the same?

Commander SCOTT: The diameter of the elongated shot was rather greater, so that it was really at disadvantage in this respect.

Captain BLAKELY: It has been pretty well proved by numerous experiments that a 68-pounder, a 56-pounder, a 32-pounder, or any of the round shot, will leave the gun at a velocity of 1,600 or 1,700 feet per second; and at five degrees of elevation, if they range 2,000 yards it is considered very good. Whereas the long shot, whose velocity has also been measured, and supposed to have been correctly measured, and does not move more than 1,100 or 1,200 feet per second, really ranges more. Those actual measurements, I think, must have great weight in coming to any conclusion. I should much like to know, if Mr. Lawrence would be kind enough to inform the Meeting, what was the exact nature of the shell?—how the soft metal was made into the shell? Did it hold powder, or was it intended to burst into fragments?

Mr. LAWRENCE: As I said before, the shell which I supplied was intended for a preliminary experiment, and therefore the capacity of the shell was by no means tested. I designedly did not make the shell so capacious as I believe it could be made. The only difference I make in the shell and the solid shot is that I have necessarily put cast-iron in the centre of the shell, for the purpose of preventing the charge blowing up the shell in the gun. That is the only difference. There is nothing but a mechanical junction between the iron and the lead or soft metal.

The CHAIRMAN: It is a cast-iron chamber?

Mr. LAWRENCE: Merely a cast-iron chamber. There is no galvanising or tinning.

The CHAIRMAN: And what sized chamber? What quantity of powder do you propose to put into the 68-pounder?

Mr. LAWRENCE: That is a matter of experiment. The contents of this shell on the

table is, I am told, about five ounces. But that is by no means fixed. I should make the shells as big as I possibly could, to hold as much powder as they possibly could; but, unless I have the means of making the experiment, I could not ascertain this point. As to Captain Blakely's other observation about the range, I can only say that I have seen an 80-pounder shot go 7,300 yards in twenty seconds. Now, I think the initial velocity of that shot must be more than 1,100 feet per second.

Captain BLAKELY: I am afraid a soft metal shell would only break into three or four large fragments.

Mr. LAWRENCE: It broke into hundreds of pieces.

Captain BLAKELY: Has it been tried?

Mr. LAWRENCE: It has. It went through an iron plating of an inch, and it broke into hundreds of pieces. There was a wooden screen at the back, and that was completely covered with fragments, and the piece of iron which was driven out was also driven into the screen at the back, and was quite warm. This shell was not more than four inches at the base, and at the top it is not more than two inches, but yet it took out a piece of iron from six to eight inches in diameter.

The CHAIRMAN: What is the relative expense of the description of shell which you advocate?

Mr. LAWRENCE: That cannot be decided unless made in great quantities.

The CHAIRMAN: What is the expense of the solid shot as compared with the rifled shot?

Mr. LAWRENCE: They cost something under 3*s.* a piece.

Captain BLAKELY: I think I can answer the question of expense. I have bought a great number, and lead-covered shot will cost about double what an iron shot would.

The CHAIRMAN: This shell would be dearer than the lead-covered shell.

Mr. LAWRENCE: I think not. I think from the report of the Armstrong shell that the cost is about the same as these could be made for. These are cast together, and therefore can be easily manufactured. They require no turning, or planing, or anything of that kind. They can be cast in the chill.

The CHAIRMAN: How do you effect the rifling of that shot?

Mr. LAWRENCE: The base of this shot is lead—the one half of it; the other half is zinc.

The CHAIRMAN: The gun is rifled, and it expands into the groove.

Mr. LAWRENCE: It expands into the groove.

Commander SCOTT: Captain Blakely has fired both iron and lead-coated shot; he knows their relative value, and can give you an account of their difference.

Captain BLAKELY: My own experience would lead me to prefer for small guns a shell very similar to what Mr. Lawrence advocates—that is to say, a shell which will enter the gun easily and expand on the same principle as his; its rear may be either lead, or paper, or wrought iron—it is all the same so long as it expands. But for anything like a large size, or for even anything like a medium size, I think such a shell is totally inapplicable. For this reason, if you let a 12-pounder shell fall on the deck of a ship, it would not be so misshapen but that it would go into the gun. But if you let a 40-pounder shell fall, and it gets a dent in the lead, you may get it partly down into the gun; there it sticks, and you cannot get it back again. The expense also is in favour of plain iron shot. The great advantage which lead-based shot have in mere experimental firing, where you do not let it fall, is that you close up the windage; but in a large-sized eight-inch gun the windage need not be so very much greater than it is in a two-inch gun; it is very much less in proportion, and really but a mere film of gas in comparison with the mass of gas which will be acting upon the shell. My own experience leads me to think that for small guns something like Mr. Lawrence's shell would be extremely good; but for large guns I confess I have recently adopted the shell which Captain Scott has so ably produced.

Sir GEORGE SARTORIUS: I do not completely understand what are the great advantages which Mr. Lawrence assumes for his shot over the common shot. Is it penetration?

Mr. LAWRENCE: It is penetration. I contend that this description of shot are very superior to iron shot, for they will penetrate plates much better; that where iron rebound, this will go through. I contend that against an iron-plated vessel an iron shot is perfectly useless, while shot made on this principle will penetrate. It could be very readily proved at a small expense; it could be tried for 10*l.*

Sir GEORGE SARTORIUS: If the experiment can be made so cheaply, and with such results, I am rather surprised that it has not been tried. So far as my judgment goes, from hearing very practical reasonings, I certainly cannot come to the conclusion you have

arrived at; viz., that a combination of soft metals, such as you propose to make, will go through iron where iron shot will rebound. Supposing the two kinds of projectiles fired with the same charge of powder, if the iron shot rebounds, I must confess that I am rather incredulous that yours will go through.

Mr. LAWRENCE: The thing has been actually tried at Shoeburyness; and, if you refer to the Iron Plate Committee, they will acknowledge, I have not the least doubt, that it did actually penetrate a piece of iron.

Sir GEORGE SARTORIUS: You mean through an inch plate?

Mr. LAWRENCE: Yes, through an inch plate; and it was stated here, and acknowledged by Captain Halsted and by Colonel Lefroy, that, up to the time of my making the experiment, no shell in the service would penetrate an inch of iron.

Commander SCOTT: I am sorry to rise again, but I think that is a great mistake. Captain Halsted, if he made such a statement, was certainly mistaken, because a 68-pounder shell will go through an inch plate very easily, and also through a two-inch plate; but it would be picked up broken on the inside, just as your shell was. I may further be permitted to give my opinion as to why the two metals you use are totally inapplicable for shells for guns of large calibres; and, after all, nearly anything will answer for small guns. It has been found in practice by Sir William Armstrong—although he has the lead so closely confined, as already mentioned, that it cannot well escape—that, if he uses a larger charge than about one-eighth the weight of the shot, he loses accuracy; and that, if a stronger powder be used, the shot cuts its way out across the grooves. Expanding projectiles also, which answer well with a small charge from a weak gun, if put into a strong gun and fired with a greater charge, are expanded irregularly. With a soft metal in front and a softer metal in the rear, the powder capacity in the centre must be extremely small to prevent crushing up. In fact, you would blow the iron chamber right through the shell if the centre cavity containing it were large, and this would be more likely to occur as the size increased; so that, with a large shot, you could not get a proportionately large powder capacity. Again, Mr. Lawrence says that, because his shots are soft, therefore they will do more harm to an iron plate than if they were hard. Now, such a thing cannot be correct; for shot of the hardest iron or steel are always found to do more damage than shot of a softer metal. He has also pointed out that the yielding properties of the soft metal shot when in the gun give it great advantage.

Mr. LAWRENCE: No; out of the gun.

Commander SCOTT: I think you said in the gun, and I wish to take it in the gun first. The soft metal, if it meets with any obstruction in the gun, will, I believe you said, easily change its shape. Granting this, it is clear that the ball, on impinging on a plate, will with readiness change its shape and become flattened down, and then a great portion of the force of the blow would be absorbed in effecting this change, and the edges which ought to cut their way into the iron would be gone. The iron shot, on the contrary, will not yield, and, from not yielding, will go through the plate. The fact being, that, if the shot of a 68-pounder does not break up, it generally goes through the plate at short distances; whereas, if the shot does break up, it does not go through the plate. If you were to fire a 68-pounder wrought-iron shot, reducing the present excessive windage, I believe it would go through the plate without any difficulty whatever.

Sir GEORGE SARTORIUS: What sized plate?

Commander SCOTT: Four-and-a-half inch plate.

Sir GEORGE SARTORIUS: What range?

Commander SCOTT: At 50 yards; you can only penetrate them at all up to the distance of 200 yards. It has been found in the firing that, when the 68-pounder shot have not broken up, they have generally gone through; and, of course, if they do break up, they do not; but, if you want to cut through a plate with certainty, you must have a cutting edge. Here [pointing to a flat-headed shot] you have a sharp circular edge that will certainly cut the plate if a high velocity be given to the projectile; and you may have a powder chamber in its rear. This is, I believe, the sort of combination of shot and shell that is likely to be used in future warfare against iron ships, because you could first cut through the ship's iron sides, and then there would be the shell in the rear to explode afterward.

The CHAIRMAN: I think that is the form of the Russian shell.

Commander SCOTT: I was not aware of it. I gave a sketch of it, as proposed by me in 1859, in my last lecture, but did not dwell upon the matter.

The CHAIRMAN: I may be mistaken.

Commander SCOTT: The advantage of the combination is so self-evident that when people

come to study the question and to understand the principles of warfare they can scarcely help arriving at similar conclusions. I may repeat one thing that I have said on a previous occasion, that I believe the value of lead coating in making the shot cut its way through numerous grooves, was a proper matter for consideration in the infancy of rifling; but now that we have so much more knowledge, and possess such mechanical facilities, we ought to have no difficulty in rifling the guns and fitting the shot without making it rifle itself by cutting its way through the grooves. This is what is really so detrimental to the breech of the Armstrong guns, as it increases the time the chamber remains under the action of the powder before the shot starts, whereas the great point is to get your shot to start as easily as possible. I do not, however, quite agree with Mr. Lawrence in the nice distinction between soft soap and grease as a means for effecting this, nor do I think that the use of either has much to do with the bursting of any gun, though perhaps the shot might be made to slip out a trifle easier.

Sir GEORGE SARTORIUS: But does not that form of shot, the flat-headed, impede its flight?

Commander SCOTT: The flat front does impede its flight to a small extent; but in no case can the present gun penetrate an armoured ship's side as far as 600 yards. I believe we shall get much more powerful guns, but at present we have nothing that will punch through a ship's armour unless close to it. There is one point which seems to me worthy of attention by every one interested in rifling, which is, that the air in front of the shot is exceedingly compressed. It is not compressed into a solid, but it is very highly compressed, and your shot is really screwing its way through this compressed air, just as a gimlet is screwed into a board, and it meets with a similar kind of resistance. I leave you to investigate this, but I believe such is the case, and Mr. Whitworth has proved that shot fired from a bore rifled with a sharp twist have a longer range than others fired from a less spiral. There is, however, a curious fact, which is, that flat-headed shot will go through water, while round-headed shot will not, as Mr. Whitworth proved. We do not yet fully understand this matter, for we have made so few practical experiments that our knowledge is very confined, and our data on most gunnery questions consist of loose generalities.

Mr. LAWRENCE: I have only one more observation to make. I think theoretical observations ought not to go against proof. I can only say that one of these soft shots has been fired and taken up again, put to rights, and fired a second time—an 80-pounder fired at a long range. Therefore, it can be readily rifled to fire in the way Captain Blakely alludes to. Now that we are getting iron-plated ships, it is of most vital consequence to us to know whether it is true or not that shots of this kind will or will not do more than iron. Other nations will not be bound by our judgment, and, if by an unfortunate fatality it should happen that this shot is more effective than an iron one, we shall be under the disadvantage of having to contend with superior projectiles, because we do not choose to go to the trouble of making them better ourselves.

The CHAIRMAN: I am sure we are much obliged to Mr. Lawrence for coming forward and giving us his views on this subject. These are new matters, and just in proportion as they are new they are liable to meet with objection. The differences that have arisen, generally speaking, arise from the difficulty of getting at facts. Nothing is more difficult in all these experiments than to get at facts. Persons jump to conclusions without having sufficient data. That, I apprehend, is the great cause of the difference. Captain Halsted says that certain shot broke up on a $\frac{3}{8}$-inch plate. It was a fact, but it was not a relevant fact, and he immediately jumped to the conclusion that all shots would break up on $\frac{3}{8}$-inch plates. It was only true that the shot would, under that particular condition, break up. It would be the same with any shot; it would break up under a certain condition. This gentleman has made experiments with a soft shot, which under particular conditions went through. But to condemn iron shot on that account would be, on the same principle, as bad as Captain Halsted's theory—that no shot would penetrate a $\frac{4}{5}$ths of an inch plate. Hence the necessity of experiments being of the minutest kind, because it is so very important that we should arrive at true results. Of course, the theory of this gentleman should have a certain measure of influence; but, really, where it helps us little in questions of this kind, it ought to be put aside altogether, until we get more facts upon which to base a true theory. It does seem, *à priori*, that he has a claim to have these experiments made; and, notwithstanding our learned friends upon such subjects pronounce *ex cathedrâ* against it, I think we ought to have the experiment made. There are conditions on which these metals do unite, and have an extraordinary character; in fact, their character alters altogether. There is no question that the character of soft

metals when combined is very materially altered. Look, for instance, at iron in the condition of smelting. If there is a quantity of sulphur present, its whole character is changed. Take a red-hot iron and put a stick of sulphur against it, and the former will drop to pieces. Such is its strange alteration of character, that when there is much sulphur present a condition is produced that will occasion the rapid breaking-up on ½-inch plates of shot so cast. But that is not to be taken as conclusive against iron shot. Without saying more, allow me to thank Mr. Lawrence for his paper.